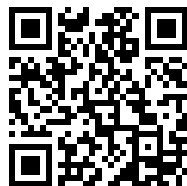

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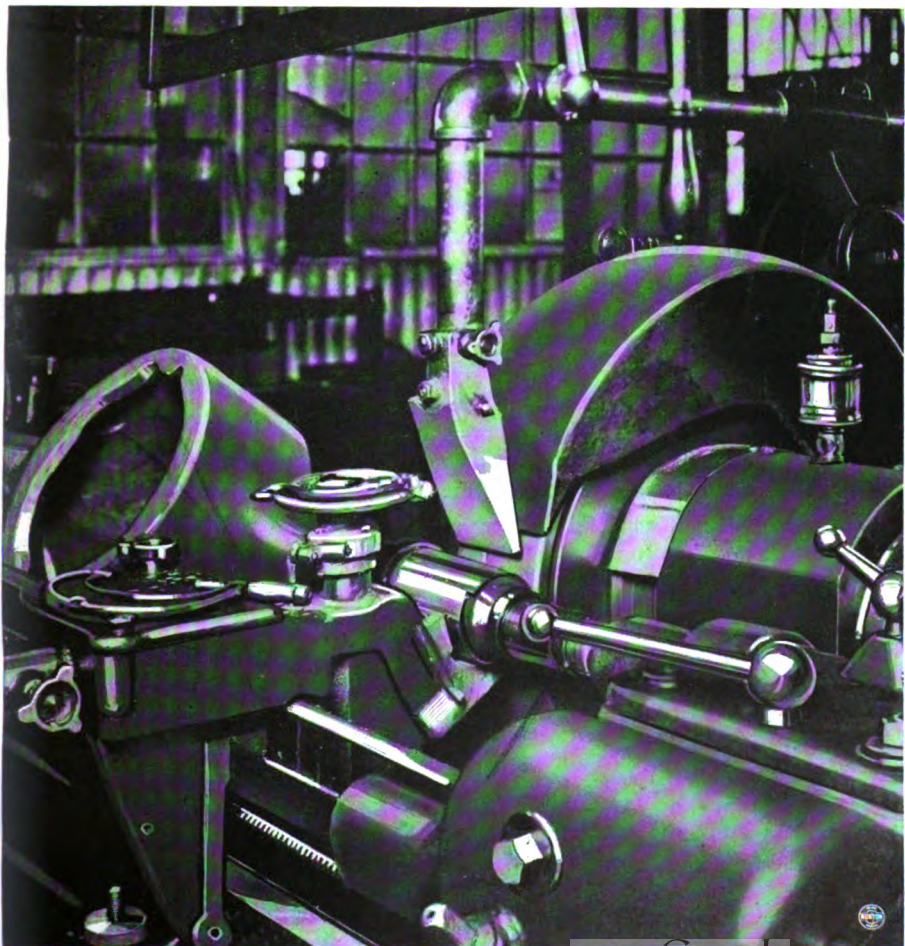
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Grinding with Cup Wheel

When selecting a wheel or adopting a method of grinding, it is necessary to consider the question of room for the chips removed by grinding.

When grinding with a cup or ring wheel, it is necessary that the work be of such form that the chips can escape. The grinding of a continuous flat surface with a cup wheel is not successful because the chips removed are confined between the wheel face and the work surface.

In some cases where the surfaces are not too large, success is gained by very rapid work speed and very shallow cuts with relatively coarse wheels. This is done to make very small chips that they may not fill the spaces between the cutting points of the wheel. Generally, however, grinding of continuous flat surfaces with ring or cup wheels is very difficult and the results unsatisfactory.

In cases where the surfaces ground are not broad, the ring or cup wheel is very successful when care is taken to secure exactly the right grade and grain for each case.

One maker of grinding machines using the disc wheel advocates reducing the area when designing all flat work in order to enable his side wheel machines to give good results.

Grinding with the Periphery

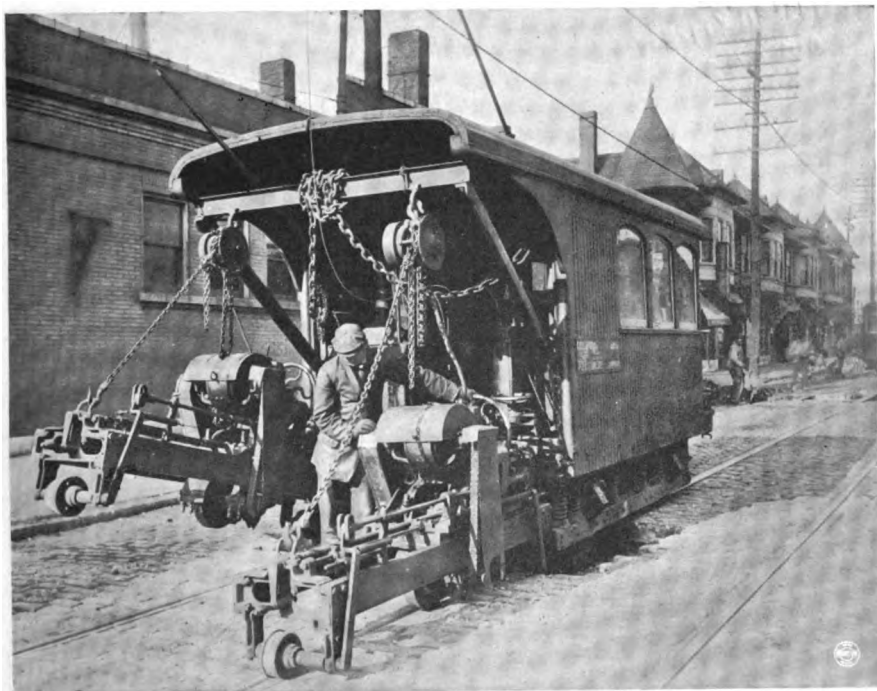
When using the periphery of the grinding wheel, the line of contact can be so

small that chips cannot be confined between the wheel and work, whether the cutting face be narrow or wide; therefore, with the same width of wheel face in each case we can cut more deeply with the periphery than with the side because the chips are not confined. It is the confinement of chips that prevents us from using the grinding wheel as we do the milling cutter, viz., a slow work traverse and very deep cut of wheel.

Deep milling cuts were not possible until milling cutters were made with very coarse teeth to allow room for the chips. We should, therefore, when deciding upon a method of grinding and when selecting a wheel, remember that the more and larger the chips we remove, the more room we must provide for them.

It has been figured out that in some cases there are as many as two billion cutting points on the face of a grinding wheel at work each minute; eight hundred million per minute is not uncommon and four hundred million per minute is very common.

When the grinding wheel is revolving at a cutting speed of about 6,000 surface feet per minute, it will be readily seen why in some cases it can remove metal more quickly than the milling cutter or lathe tool. It is also apparent that the character of the abrasive material used in the wheel is an important factor as well as the grain and grade.



The Alundum Wheel a Part of Electric Welding Equipment

The process of welding rail joints and bonds by electricity was introduced in 1897. To a constantly increasing extent during recent years this process has been applied both to the welding of the standard tee rail on exposed track and to the welding of all conductor rails on surface and elevated car systems. In the welding of a standard tee rail track, expansion joints are made use of, thereby preventing any trouble that might arise from expansion and contraction. The joints are adapted equally well to the welding of either new or old rail. In the latter case old track can be reclaimed by welding the joints and regrinding them. Such

a process insures a double benefit—smooth riding and many years of additional wear.

After welding has taken place, the grinding machine is moved into place and the joints are smoothed over with a 16 x 3 x 1½, 14 R Norton Alundum Wheel. The machine used for doing this work is called the Kleinschmidt Grinder. It is the only machine in use on which the grinding wheel travels on its own track; moreover, the adjustments are of such a nature as to produce an absolutely straight surface on the rail joint.

The manufacturers are the Lorain Steel Company, Johnstown, Pennsylvania.





The interesting grinding operations shown on the opposite page are:

Grinding Hardened Steel Ball Cups

Surfacing on a Pratt and Whitney Vertical Surface Grinding Machine

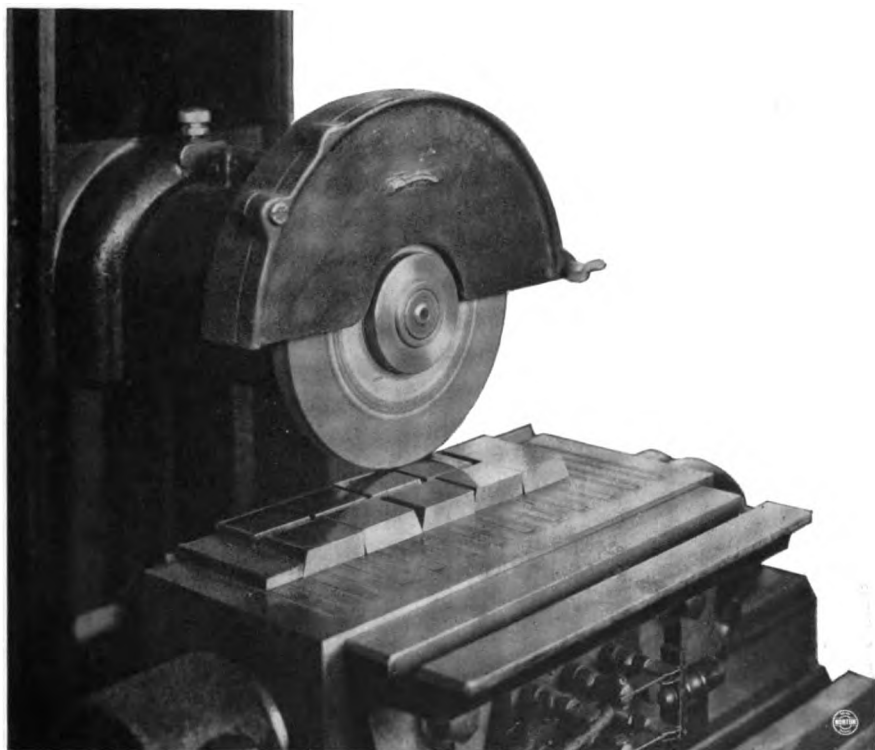
Grinding to Size Taper End of Driving Shaft

Grinding Steering Gear Shafts at Chalmers Motor Car Co.

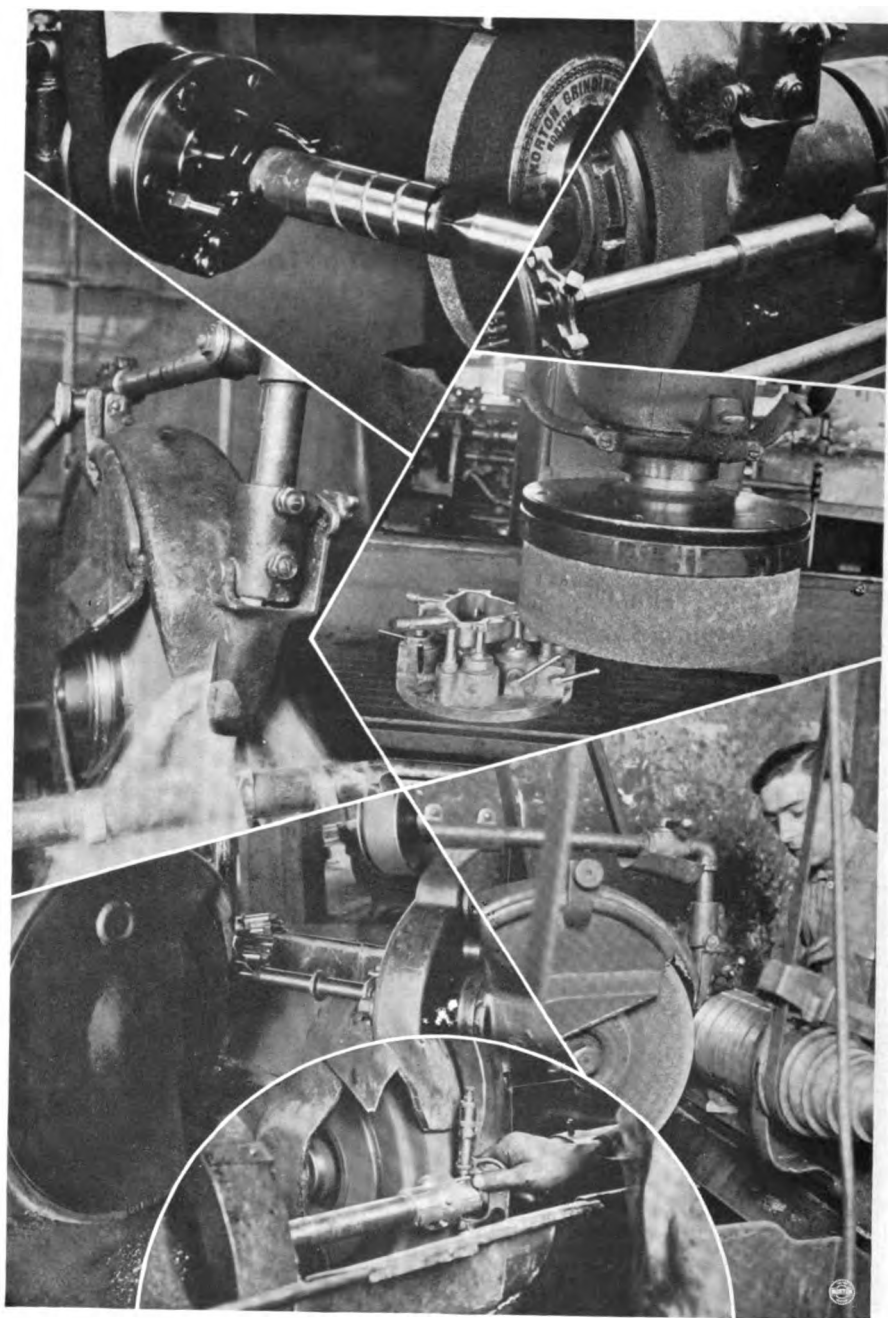
Grinding a Water Pump Shaft of Carbonized Steel

Grinding Steel Crank Shaft

Alundum wheels are being used in each instance



150 Pieces Per Day Removing .500" Stock are Finished with this Operation using a 7 x $\frac{1}{2}$ x $1\frac{1}{4}$ ", 3846 I, Alundum Wheel. The Feed is .030". Limits of Accuracy .001".
The Machine used is B & S Surface Grinding Machine Equipped with
Heald Magnetic Chuck



The interesting grinding operations shown on the opposite page are:

Brown and Sharpe Machine Grinding Tool Steel

Grinding Bushing for Gear Box Lathe

Grinding Cam Shafts for Cadillac Automobiles

Surfacing a Motorcycle Crank Case Housing

Facing Surface of Seldon Stud

A Norton Cylindrical Grinding Machine at Work

Grinding Change Gear Bushing



An Interesting Grinding Operation—Special Crossing Open Side Planer Grinder used for Surface and Line Grinding of Manganese Steel Steam and Street Railway Crossings. The Work is Levelled up and Moulded to the Bed, Insuring a Uniform Surface and Accurate Straight Line, the machine being Operated the same as an Ordinary Planer. Alundum Wheels, 18 x 2½", grain 16, Grade P, remove the Stock Efficiently at 1800 r. p. m.



Little Known Facts About Grinding

Steadyrest Work Shoes

By HOWARD W. DUNBAR

Many times we are asked why we use hardened steel shoes in some cases and wood shoes in other cases. It may be helpful to explain at this time the reason for these different conditions.

Normally, in the production of commercially ground parts in large numbers, the work shoe must be of such shape, size and proportions as to remain a constant factor in the grinding operation, because the operator is constantly turning out piece after piece at short intervals. If he had to take into consideration variation in size due to change in the work shoe, his production would be cut down materially. Therefore, the hardened steel work shoe of the size of the finished work for finishing, and of the size of the rough ground work for roughing, provides a means of supporting the work and removing one of the variables in the grinding operation, because the hardened steel work shoe retains its size longer and can be depended upon to produce parts of the same size, piece after piece, without consideration on the part of the operator.

Where a machine is used for general all-round grinding, when there are seldom more than one-half dozen pieces to be ground at one given time, it would be manifestly unreasonable to hope to have hardened steel shoes of the proper size for all the various pieces being finished. Therefore, a steadyrest with adjustable wood shoes is provided which has a range within the capacity of the size of machine being used, and can be readily adjusted to the diameter of work being ground.

Much discussion has been met with in connection with the use of hardened steel shoes, because, it is argued, the work being ground is liable to be scratched. This has proved to be a false line of reasoning, and it is readily understood when

one considers that the steadyrest shoes of soft material will pick up particles of dirt, abrasive, chips, etc., and retain them, really converting the shoe into a lap; and consequently the hardened steel shoes will not become imbedded with these particles so easily. Therefore, if it fits the work properly and is in line with the work, hardened steel is less apt to scratch than the soft materials.

In the case of hardened steel shoes it is very important that they be properly constructed and properly mounted in the steady rest. The shoe must present a considerable portion of its bearing surface to the work being ground. It must be in line with the axis of rotation of work, securely fastened in the steadyrest, and properly hardened and smooth.

The other forms of steadyrest do not need such careful attention as the hardened steel for, since they are soft by nature, they quickly wear to a point where they meet all of these conditions. The fact that the hardened steel shoes do *not* wear so rapidly is the reason why they must have more attention in the making.

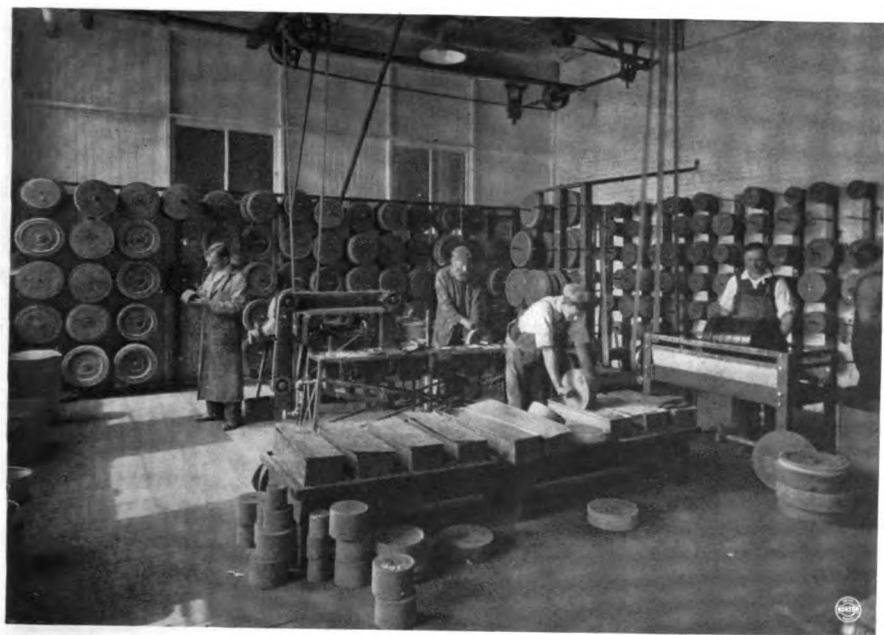
A Good Polishing Department

The following photographs were made in the polishing department of The Billings & Spencer Co., Hartford, Conn. On 80% of the wheels set up in this department Alundum grain is used. Kinds of wheels set up are rag, block, felt, disc and strap. The sizes vary from 4" to 18" in diameter and $\frac{1}{4}$ " to 5" face thickness. The grain numbers used are 60, 70 and 80 Alundum. The block wheels are used for roughing ratchets, screw drivers, pliers, hammers and adjustable wrenches of all kinds and sizes made from tool steel. Number of abrasive 70.

Attention is called to the arrangement of machines, the equipment of dust hoods, and the excellent dust exhaust system.



GRITS and GRINDS



[May, 1918]

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Grinding Kinks

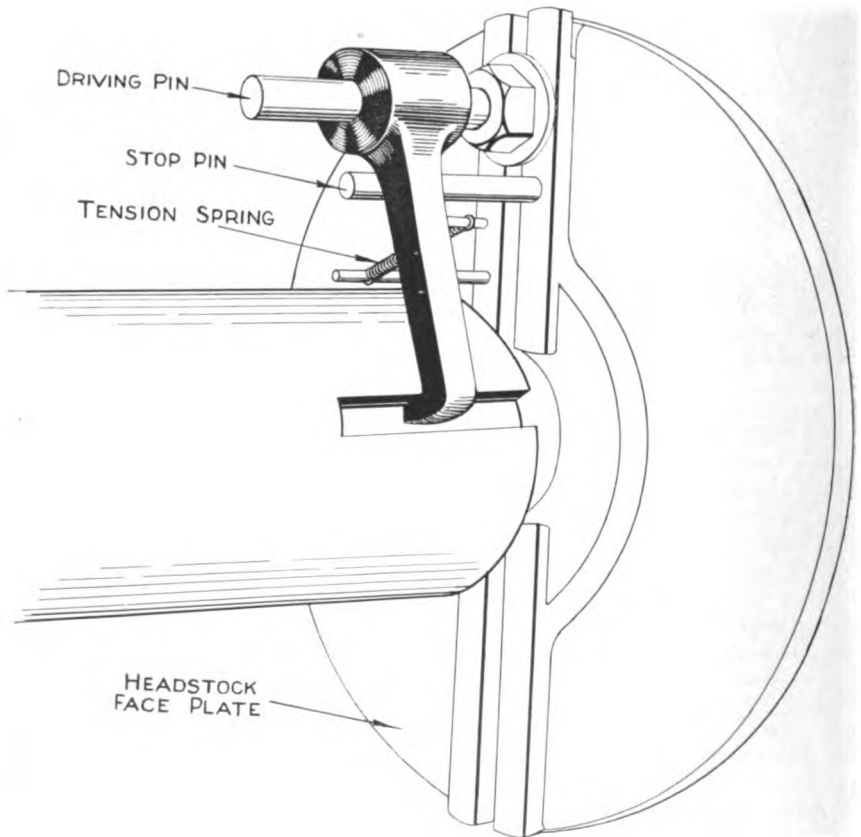
Driver for Shaft Having a Spline or Keyway in the End

BY HOWARD W. DUNBAR

The accompanying illustration, so far as its application to grinding work is concerned, is clear in itself. The hook driver which engages the spline or key way should be hardened on the nose and fastened to the driving pin on the face plate of the machine. The adjustment of tension

on the little spring is important so as to provide sufficient pressure to hold the driver engaged while revolving.

The scheme allows the operator to place the work on centers without regard to the driver, which automatically engages the keyway as it revolves.





Oscar Nordstrom Now At Cincinnati

What is always the safest judgment to make about the quiet man? Just this—you never can tell what is there until you know him better. Oscar Nordstrom is just such an enigma. If you call him quiet, perhaps you will change your first opinion, once you have heard a little about the strenuous activities of his private career.

He was first heard of in Worcester, Mass., and received his education in the Worcester schools. Previous to 1903, the year in which Mr. Nordstrom came to the Norton Company, he was employed for a short time by the Allen-Higgins Wall Paper Co., Worcester. After that he became associated with the Chemical Laboratory of the Norton Company, where he began work in 1907. His next change proved to be the first step toward obtaining the kind of experience that is valuable to an outside grinding wheel representative. After two years in the grinding wheel plant, Oscar again changed his field of activity to the Norton Grinding Company where he derived a practical experience in commercial grinding. This he regards as his most valuable asset in his present work, and Norton grinding wheel users in and around Cincinnati will soon agree in this respect if they have not already had some dealings with him.

During the following three years he added a new chapter to the novelty of his previous career. By close application in the Norton Company Mechanical Laboratories he obtained a good knowledge of grinding wheels, machines and requirements. This knowledge was put to use by a short experience of one year in the automobile industry as demonstrator. In 1915 he started out in a new field and one which he has pursued ever since—



that of salesman and demonstrator for Norton grinding wheels. For two years he was associated with the Philadelphia agency. He was then given the Baltimore territory where he made good to such an extent that when an opening came in the Cincinnati district Mr. Nordstrom was assigned to that important field.

**The direction of grinding
machine operators should
not be entrusted to
clerical minds**



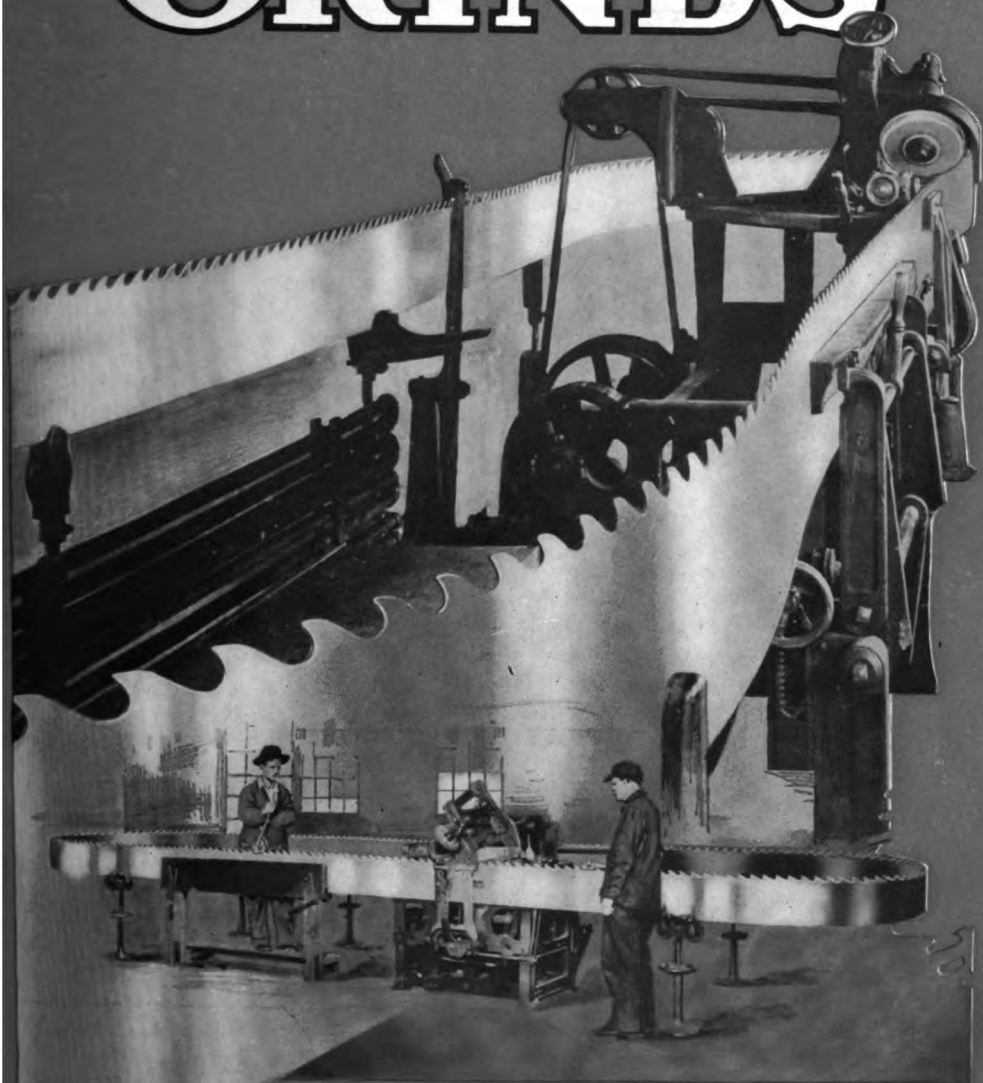
Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

- Interesting Examples of Gage Grinding.** American Machinist, March 21, 1918, page 487. Account of some devices developed at the shops of the Blain Tool & Machine Works, Inc., New York, N. Y. Illustrated.
- Grinding Precision Tools.** American Machinist, March 21, 1918, page 494. The writer describes his method of measuring angles on precision tools.
- Grinding Equipment a Necessity even on New Rail.** Electric Railway Journal, March 16, 1918, page 518. The writer emphasizes the necessity of rail-grinding equipment and discusses types of rail-grinding machines.
- Portable Electric Grinding Machine with Speeds up to 30,000 R. P. M.** Electric Railway Journal, March 16, 1918, page 532. An account of a grinding machine manufactured by the Wisconsin Electric Co., Racine, Wis.
- Ott Plain-Grinding Machine.** American Machinist, March 28, 1918, page 553. Description of a machine manufactured by the Ott Grinder Co., Cincinnati, Ohio. Illustrated.
- Bridgeport Surface-Grinding Machine.** American Machinist, March 28, 1918, page 554. A surface-grinding machine marketed by the Bridgeport Die & Machine Co., Bridgeport, Conn. Illustrated.
- Manhattan Universal Grinding Machine.** American Machinist, March 28, 1918, page 555. A universal tool grinding machine marketed by the Manhattan Machine & Tool Works, Grand Rapids, Mich. Illustrated.
- Defiance No. 50 Valve-Grinding Machine.** American Machinist, March 28, 1918, page 555. A machine used for grinding in the valves of gas-engine cylinders; manufactured by the Defiance Machine Works, Defiance Ohio. Illustrated.
- Grinding Shrapnel Punch-Tool Bits.** American Machinist, April 11, 1918, page 611. The writer tells how to grind these tools in an efficient way. Illustrated.
- Luther Improved Grinding Stand.** American Machinist, April 11, 1918, page 640. Improvements in the No. 271 "Hummer" grinding stand made by the Luther Grinder Mfg. Co., 285-289 South Water St., Milwaukee, Wis. Illustrated.
- Grinding Allowances.** Canadian Machinery, April 11, 1918, page 379. Discussion of the factors to be considered in determining the amount to be left on turned or bored work which is to be finished to size by grinding. Illustrated.
- Polishing Etched Steel Plates.** Metal Industry, April, 1918, page 162. An outline of the steps to be followed in this work. Illustrated.
- Grinding Wheel Truing Device.** Machinery, April, 1918, page 744. Made to dress wheels to an exact radius of curvature. Illustrated.
- Grinding Fixture.** Canadian Machinery, March 28, 1918, page 319. Used for grinding and regrinding the roughing and finishing blades. Illustrated.
- Portable Bench Grinding Machine.** Iron Age, April 18, 1918, page 1009. A grinding outfit made by the Temco Electric Co., Leipsic, Ohio. Illustrated.
- Extra Feed-Finger for Grinder.** Woodworker, April, 1918, page 40. It operates automatically and can be attached quickly, to be used in grinding a band saw with broken teeth. Illustrated.
- Gale-Sawyer Toolpost Grinding Attachment.** American Machinist, April 25, 1918, page 724. Marketed by the Gale-Sawyer Co., 33-37 Wormwood St., Boston, Mass. Illustrated.

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GRITS and GRINDS



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Grits and Grinds

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Saw Gumming

By W. A. SCHEUNEMAN

Speeding up production for war purposes in all branches of war work has its many dependent forces, with the one force more potent than the rest. And thus we find to-day in the wonderful work being done by the almost innumerable lumber mills in turning out ship timber throughout our great forest lands that the output depends upon that workman, now so wrongly named, the "saw-filer."

Modern inventions, automatic machinery of all types, almost human contrivances for "tensioning" and "swaging" and, last of all, the grinding wheel have made the work "of the man who takes care of the saws" almost entirely a job where hardly a file is used to-day. He surely isn't a saw-filer. What shall we call him? But it makes little difference and we will stick to tradition and henceforth in this article refer to him as a saw-filer.

Incidentally it may be mentioned here that the grinding wheel is used in a war industry which few of those interested in grinding wheels realize. It is sharpening all the saws for cutting the timber that is being used in the construction of our wooden ships. The grinding wheel is indirectly helping to win the war "over there."

The old emery wheel first supplanted the file, and now that emery is passing away, it is the modern grinding wheel made from artificial abrasive that is taking the lead.

Here again it is hard to change the old names, and the filers will still persist in referring to what are now known as grinding wheels as emery wheels.

The file is still used to file the points of the teeth immediately after swaging, in some instances to file the back of a new saw and to file away the "blue spots" on the teeth caused by too heavy grinding. Some filers will also use the file to test the teeth of the saw if they think the wheel has casehardened them.

But, you may ask, why is the filer so important? The answer is an easy one—the condition of the saws depends on the filer and the output of the mill depends upon the condition of the saws. Although it must not be forgotten that the production depends partly on the sawyer, nevertheless, without the proper saws his work could not be as efficient as it usually is. Proper co-operation between the sawyer and filer is a vital factor in the output of any mill. Very often a grinding wheel is the butt of many complaints when this co-operation is missing.

Band and Circular Mills

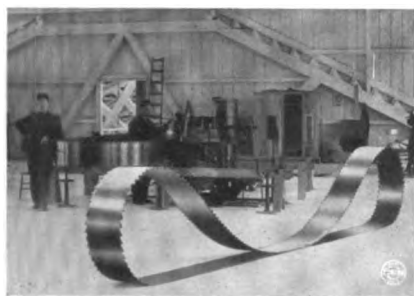
The majority of the saw mills to-day are band saw mills, which greatly outnumber the circular mills, although every mill has some type of circular saw such as slasher, edger, trimmer and shingle saws. Gang saws are also used in many mills while band resaws, which are smaller in

gauge and width than the larger bands, are frequently used.

Each type of saw requires a different setting of the wheel, the saw gummer head and usually a different thickness of wheel. Of course it is obvious that a different machine is used for each type of saw.

Types of Saws

The following will give an idea of the dimensions of the work a grinding wheel is required to handle in a file room.



Band Saws

Band saws may be of any length, but the average length used in the band mills to-day is from 44' to 50' and from 10" to 14" in width. They may be as long as 54' or 68' and the width may be as high as 18". The gauge may range from 16 to 12, though they generally average around 14. Most filers prefer a single cut band, but others prefer a double cut. Band resaws range from 24' to 26' in diameter and are from about 6" to 10" wide. The gauge seldom goes over 13. However, many filers make resaws from their worn-out bands and the gauge while thinner than the original band will be thicker than the ordinary resaw.

TABLE 1

Gauge No.	Thickness in Inches	Gauge No.	Thickness in Inches
7	.1875	14	.0781
8	.1719	15	.0703
9	.1563	17	.0625
10	.1406	17	.0563
11	.1250	18	.0500
12	.1094	19	.0438
13	.0938	20	.0375

TABLE 2
Wheel Speeds

Diameter	R. P. M. for 5000 S. F. P. M.
6	3200
8	2400
10	1900
12	1600

Another type of band is the so-called thin or narrow band. These seldom go over 24' in length and run from $\frac{1}{8}$ " to $\frac{1}{4}$ " in width. They are very thin, running in gauge from 20 to 23.

Circular Saws

These are of varied types.

To judge from those used in a circular mill for regular mill work, they may come as big as 6' in diameter when new. These may be as thick as gauge 5.

Some mills use the inserted tooth saws which give the saws their original diameter continuously. This consequently offers just another grinding problem.

Another type of the large circular saw is the so-called "cutoff" saw which cuts the logs into workable lengths at the top of the log pull. This, however, does not require very frequent grinding.

The slashers, edgers and trimmers may be grouped together. They are as a rule much smaller than the above saws, ranging anywhere from $1\frac{1}{2}$ ' to 3' in diameter and about 7 or 8 gauge.

Shingle saws can range from $2\frac{1}{2}$ ' to 5' in diameter and 7 to 9 gauge at the center and about 16 to 19 gauge at the toothed edge.

Gang Saws

Gang saws are almost always made by the filer from old bands or band resaws. At least, the filer who doesn't proudly boast of his gangs made from his old bands and the-money-he-saved-the-company-and-the-little-credit-he-got is very rare.

Gang saws are from 3' to 4' in length and about 6" wide. By the time they are made they are about 16 gauge.



Another saw that may perhaps be listed under this type is the drag saw which some mills use to cut the long logs instead of the "cutoff" saw. It is about 5' long and about 8" wide, and is usually 10 to 13 gauge. Like the "cutoff" this saw requires very little grinding.

Each of the above types has its own shape of teeth and that in itself would offer its own grinding problem.

The Important Factors in Good Saw Sharpening

As with every grinding problem, many factors enter into the proper solution of saw sharpening, so that many items must be considered in the proper gumming of saws. However, three besides the filer himself stand out as more important than the rest. They are the filing room, the machine, and the wheel.

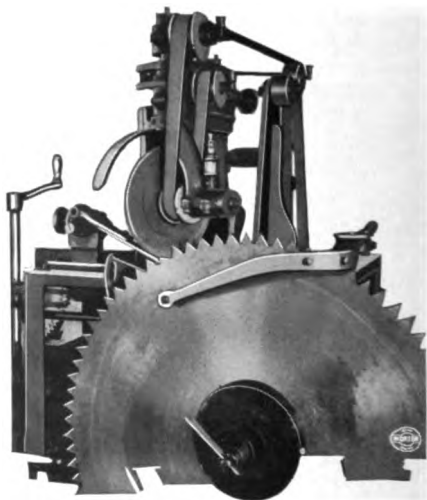
The Filing Room

To those who are unfamiliar with this operation the filing room may not seem to have much importance. Yet when one considers the first statement in this article—that the filer is the most important man in the quantity and quality of the output—it can be seen that the filing room need well be considered, since it is the workshop of that personage. It is indiscriminately placed on the mill floor, at the side of the mill, attached or detached, or in the attic. The type of the mill should determine the location, but before the builders and owners of mills realized this importance the file room was located in any place where there was room.

The ideal location for a file room is on the side detached from the main body of the mill, on the same level as the mill floor. Detached from the mill the room will not be subject to the vibration of the mill caused by the carriage nigger, bullwheel, and the rolling around of the logs.

A solid foundation for the filing room is the vital item to consider. No sharpener

or lap grinder will do good grinding if its foundation is vibrating continuously. It will cause even a wheel on a new machine to grind incorrectly and will eventually ruin the teeth. Moreover, it will prevent the smooth grinding and will not give the clean, sharp edge that a filer likes to see on the teeth.



Circular Saw

Most of the larger mills are double bands and then it is almost essential to have the filing room overhead. This is the usual practice in the majority of mills. It is in these cases that this question of vibration becomes a real problem. It is almost impossible to get away from it, unless the building is so designed. New construction makes the mill strong enough to get away from it. Many complaints against grinding wheels, if more carefully considered, could be traced to this vibration. It is now the practice in some mills to go over the entire building and have all stays and bolts drawn up tight again. This reduces the vibration, helps the filer, and keeps the building in good condition.

Machine Conditions

As already intimated, machine conditions depend partly on the vibration of the filing room. However, the natural wear on the machine, together with the attention given the machine by the filer or his helper, is also a factor in its proper condition.

Careful attention must be given to the cams, the cam rollers and bearings.

The cams and cam rollers especially need careful attention. The cams wear out, they become timed incorrectly, with the result that the grinding wheel will bang down in the gullet and naturally cause the wheel not only to wear away, but to spoil the wheel face and as a consequence spoil the tooth shape on the saw.

If the machine is not properly oiled, the rollers may stop rolling and this is one of the causes of the cams wearing incorrectly.

With no arrangement for removing the grinding wheel dust, the bearings also need careful watching. The "banging into the gullet" above mentioned also means hard wear on the wheel spindle bearing.

It may often happen that the back edge of the band saws may wear a groove in the supporting block under the grinding wheel. Unless this is kept smooth it may produce a condition that the filer may never notice, since it may bind the saw when being advanced by the feed finger. In such a case the teeth will not be placed properly for grinding. Thus, the face may be ground too hard and the back of the next tooth may be missed altogether.

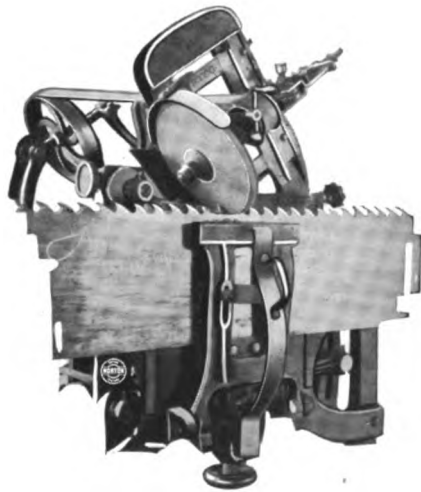
The Grinding Wheel

When saws begin to show cracks, when they begin to caseharden, and when other things go wrong in the filing room, even though a wheel may be satisfactory until the trouble starts, it is usually the grinding wheel which receives the blame, because no other reason for the trouble can be found.

However, the average filer must be given credit for becoming more educated every day with regard to grinding wheels. He is learning to look upon his wheel as one of his tools and is beginning to treat it as such.

As already shown under the discussion of the filing room and machine conditions, there are many things which influence the action of the grinding wheels in the filing room.

Wheel speeds cannot be depended upon in a filing room where the machinery is run by individual steam engines. The steam line as a rule is connected with the same line as that which furnishes steam for the carriage gun. The number of machines used controls the steam supply and power delivered. A change of 200 to 300 r. p. m. of the wheel may result from a change of only one or two revolutions of the steam engine. When it is realized that a change of 500 surface feet will show an appreciative effect in grinding action, it can be seen that this change is a vital one.



**Grinding the Band Saw, Showing the Wheel
in the Gullet**

Reference to Table No. 2 will give the generally accepted correct speeds for wheels, the sizes of which are usually used in saw gumming work. These speeds will give approximately 5000 s. f. p. m.

A good saw gumming wheel must combine the opinions of every saw-filer to-day. The following can be considered this combined statement—it must be a good cutter and above all a cool cutter, so that it will not burn and caseharden the saw. The latter requisite usually demands a soft wheel, but the saw gummer must be hard enough to hold its shape and to give a reasonable life. A good finish must also be produced.

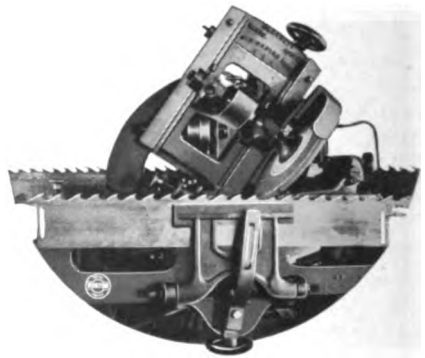
Any grinding wheel must have the ability to hold its shape or contour in order that the correct tooth shape may be held. This is a delicate point with every filer, and a wheel which ruins the shape of the teeth of his saws will be discarded at once.

With the high speed steel saws which are being used to-day a wheel of open structure is more successful than one of closer structure. A dense wheel is liable to burn more readily than the open wheel. The latter will always cut cooler, will invariably break away more readily, and cut faster.

The grade of a wheel is naturally of importance. The speed of a wheel enters into this point, for a wheel which is acting too hard may be running at too high a speed, whereas a wheel that acts soft may be running too slow.

The average filer prefers a wheel of a grade which the grinding wheel manufacturers choose to call medium. Some will prefer a slightly softer and others a slightly harder wheel. Those that prefer the softer wheel are usually accustomed to taking a heavier cut than those preferring a harder wheel.

The filers who use an especially soft wheel base their preference on the fact that the wheel is certain not to burn their saws. Their argument, however, seems



Band Resaw

unjustified, for the softer wheel loses its shape much more readily than the harder wheel and gives only a short life, these factors being hardly outweighed by the first. The matter of attention seems to be at the base of this, for the same filer could readily use a harder wheel if he were willing to give it the proper care.

The harder wheel seldom glazes in the operation of saw gumming. It will often load, but not always with the steel. The saws coming off the band wheels where pine and other gummy woods are cut will often load the wheel with the gum and prevent the wheel from cutting properly. This will often cause the wheel to burn the saws and the filer may think the wheel too hard, whereas a little dressing after the first round would make the wheel act satisfactorily.

The question of concave and straight wheels, according to the writer's opinion, is one to be solved by each filer. The contention of those filers using the concave wheel is that it gets away from the shoulder which is worn on the side of the wheel by the point of the tooth, as the wheel enters the gullet. They also claim that they cannot swing the head of the machine around far enough, and give the saw clearance and get away from the

shoulder. However, those using straight wheels get just as excellent service as those using the concave, and they seem to be able to swing the head around far enough. The shoulder may come, but these filers do not find it objectionable.

When the hook used is very great, the matter of clearance mentioned above is no doubt of very great consideration. Then a concave wheel would of necessity have to be used. The amount of concavity is apparently also a matter of each filer's choosing.

There surely is no set rule that can be laid down for concave and straight wheels.

Wheel thickness naturally depends upon the size of saw and the size of teeth.

Actual Grinding

The actual grinding of saws can be divided into two distinct operations. These are called "pointing up" and "roughing out." Pointing up requires only very light cuts and is the operation which takes place when a saw has just come from the band wheels after a regular change. Two times around the saw are then sufficient to put the wheel in shape for the mill again. After about two days of use the saws have to be swaged once more. Then perhaps four rounds are necessary to put the saw into shape for work.

Logs may be frozen up and sometimes even rocks may become imbedded in the bark. Spikes likewise are often found in the logs. These conditions often cause much trouble. A saw will hit such obstructions and invariably strip. A considerable number of the teeth will be stripped off. This will necessitate a change of saws at once and will give the filer extra work. At this point the operation of "roughing out" takes place.

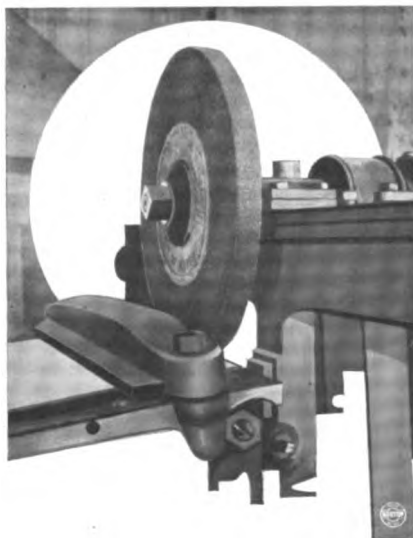
The operation requires much grinding, since it is necessary to bring all the teeth to the same level as the prospective new ones which are to take the place

of those that were stripped off. It will probably take a few hours of heavy grinding for this operation.

Most filers do not use the same wheel for "roughing out" as "pointing up," since the heavy grinding would wear the wheel away. It is seldom that a filer has not a wheel hanging on his wall that was too hard for "pointing up." The average filer will save this wheel for the operation of "roughing out." It may burn the saws, but a few finishing rounds with the softer wheel will remove the burn and the saw will be in good condition once more. This is the hardest grinding that is encountered in a filing room.

A similar operation may occur when a filer makes a saw from a blank. This requires the filer to stamp the teeth in his saw and then shape them correctly with his grinding wheel.

These operations, although varying slightly with the different types of saw, are essentially the same, no matter what kind of a saw.



Lap Grinder

Dressing of the Wheel

The usual practice in a filing room is to dress the wheels with a bunch of washers loosely mounted on a long bolt, or an old piece of grinding wheel. The washers, however, seem to have the preference. Some use both.

That no better method for dressing saw gumming wheels has been devised is unfortunate, as the washer method removes so much wheel for the result desired. A large percentage of wheel wear is due directly to dressing the wheel. Dressing is

not only required to sharpen the wheel face, but to keep the proper contour of the face.

It can readily be seen why a soft wheel will give such short life. It not only wears away quickly, but loses its shape face so readily that it requires just that much more dressing than a harder wheel.

On gang saw and some types of circular saw sharpening, the operation is such that very little dressing is required.

(Concluded on last page)

Little Known Facts About Grinding

Grinding Cast Iron Pistons

By HOWARD W. DUNBAR

Norton Grinding Co.,
Worcester, Mass.,
Dear Sir:

Kindly give me some information on grinding we have on hand. We use your 10 x 36" machine and are grinding pistons for gas engines. Lately we have been getting soft castings and find it hard to produce fine finish. We use an 18 x 2" wheel, Grain 24, Grade K. Piston diameter is 3 1/8". I would appreciate your advice with regard to getting good finish on cast iron pistons.

Dear Sir:

With regard to the grinding of cast iron pistons in an effort to get a fine finish, we must state that we are unable to tell you in a letter just how to do this. Finish on cast iron, as on any other part, is usually a matter of the opinion of the observer. What might be a fine finish to one would be a very poor finish to another. It depends upon the viewpoint of the observer.

Finish, of course, is produced with a wheel trued to a surface which will in cutting produce a certain condition upon the surface of the piece being ground. The smoother the wheel is trued, the more

nearly the wheel becomes a lap or burnishing tool, and the greater will be the reflecting surface produced. This is more readily accomplished on steel than on cast iron, because of the nature of the material operated upon.

The wheel you are using, assuming it to be a Crystolon wheel, although a soft grade, is a good wheel for the job. We say this with the thought that you must produce a good many pistons a day and at the same time get a commercial finish. If you were after finish alone then a little harder wheel would be better as a finishing wheel. Still, if the wheel is properly trued so that it is a perfect cylinder, and so that the particles are rounded slightly by traversing the diamond across the face of the wheel very slowly, taking a very shallow cut, a good finish is possible with a soft wheel. To procure a finish is an art and is accomplished only by long years of practice and experience on the part of the operator. In our factory we do not care to see a high, glossy, reflecting finish on a piece of ground work, because if such a condition exists we know that it has been done at the expense of production and required a long time to accomplish the results.

Plenty of lubricant should be used on work being ground when you wish a fine finish. The wheel must be perfectly true, in good balance, and the work revolved at a speed which gives the proper relation between wheel and work. This may be determined when the wheel cuts properly, produces correct and accurate work, and the required finish.

As a general rule, finish is the last thing to be considered. Accuracy first, production second, and then as good a finish as these two other elements will permit.

A commercial finish, to our mind, is one that does not show the reflecting qualities of a burnished piece of work. This is the proper finish for ground parts and, in our judgment, would be the proper finish for cast iron pistons.

We hope that this letter, although indefinite in detail, gives the facts concerning the essentials in finishing good work and will help you in your difficulties. Under separate cover we are sending you a copy of our booklet "Little Known Facts about Grinding," and assure you that we are glad to be of service at any time.

Charles H. Cutter of Indiana

When they're told to "go over the top" there isn't anybody who cares much how they climb out and go over so long as they *do* go over and do the job right. There may be no blare of trumpets announcing the arrival of Charlie Cutter—he just happens along quietly, worms his way around the plant until he reaches the place where grinding wheels are used and the man who has the "say" about wheels. But Cutter makes good, that is the principal thing. He makes good, in the writer's opinion, because he gets in touch with the man who uses grinding wheels, gives him the benefit of his experience—and that means that the employer who buys Norton wheels is going to profit by reason of more satisfactory results.

As far as we were able to find out, his first occupation was that of cabinet maker. He forsook this occupation to enter the machinery and mill end supply line in Chicago where he was located several years. You might call these years of work the apprenticeship for his Norton career, for at this time he acquired most of his first-hand knowledge about machinery and grinding.

In February 1911, he entered the Norton service and was placed in the Chicago



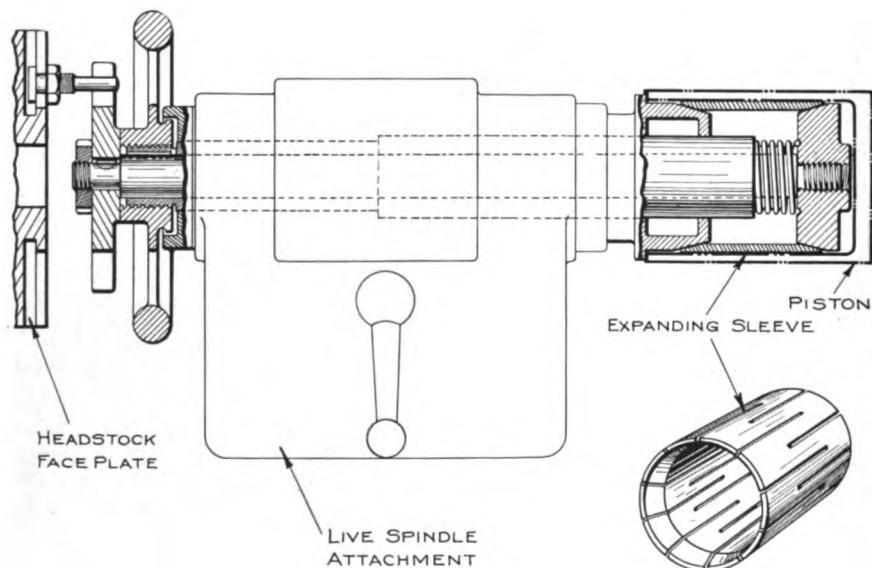
C. H. Cutter
Anderson, Ind.

Store. His first territory was Indiana, which apparently appealed to him as a state in which to reside, for he makes his home in Anderson. His present route covers central Indiana, northern Kentucky, and eastern and southern Illinois, and his good record here has been established.

Grinding Kinks

Fixture for Grinding Shells

BY HOWARD W. DUNBAR



We are illustrating this month a fixture for grinding shells or caps formed from sheet metal, forgings or castings. This is particularly well adapted to thin shells because the construction of the expanding arbor is such that a three-point bearing is obtained at either end of the shell or cylinder, and of such proportions that it will distort the member being ground the least of any known device at the present time.

Such an arrangement must of necessity be used with a live spindle attachment, the work being slipped over the arbor and

held in place by tightening up with a hand screw on the back of the live head which draws the bolt carrying the expanding members into the split shell. The angle on the ends of these expanding members engages the ends of the split member and causes it to bind on the internal diameter of the piece being held.

This form of holder for work has been successful on shells as small as $1\frac{1}{2}$ " in diameter, $2\frac{1}{2}$ " long, with a wall thickness of less than 1-16" and has also been used successfully on Liberty motor cylinders.

"Grits and Grinds" Men in the Service

Of the five hundred and seventy soldiers of Uncle Sam represented on the Norton service flag, several are well known to many readers of "Grits and Grinds," through contributed articles appearing in these pages or through personal acquaintance gained in business experiences while representing the Worcester and branch offices. Most of these men have already won commissions in some branch of the army.

Captain R. G. Williams, who was a member of the "Grits and Grinds" editorial board, was one of the first to enlist and for more than a year has been doing very important work in the Ordnance Department at Washington.

Leslie C. Griffin, formerly a Norton sales representative in the Southeastern States, entered the service last fall as a private and has advanced rapidly until he is now a lieutenant acting as instructor in one of the large artillery schools in a Southern cantonment.

W. R. Fletcher, who is well known in the Chicago district, recently won a commission of lieutenant in the Aviation Corps and is flying at Wright Field, Dayton, Ohio.

Lieutenant F. G. Everett, once a member of the Worcester sales force, has been in France for nearly a year acting as interpreter in the Intelligence Department and has seen duty in all sections of the American front.

A. R. Miller, late of the Norton headquarters in Detroit, has been given the commission of lieutenant in the Ordnance Department and is doing investigation work at Washington, D. C.

Lieutenant W. H. Chapman, formerly of the Norton Research Laboratories, is serving on a special commission of ten engineers who are developing newly improved equipment for airplane observation and bomb dropping devices. He

has been in charge of a special machine shop in the neighborhood of Paris since the first of the year.

Captain E. V. Wenzel, who has made a large acquaintance in the East and Middle West as a sales representative of the Norton Grinding Company, has had charge of a company of thirty soldier machinists who learned to operate grinding machines for a while in the shops of the Norton Grinding Company and later at Watervliet Arsenal. It is reported that he has sailed to one of the large ordnance bases in England or France to carry on the same work.

In Captain Wenzel's company are three other Norton men familiar to "Grits and Grinds" readers. They are: Sergeant W. R. Moore and Corporal George A. Parks of the Worcester sales organization and Private Nelson Hillstrom of the New York Store sales force.

Those who are interested in the Norton Refractories will be glad to hear that Sergeant Frederick Grant, who has been training in Texas for six months, has at last realized his ambition and has arrived in France.

Two members of the Sales department who have only recently entered the service, but are studying for commissions are: Steve Anderson, once located in Japan in the interests of Norton wheel users there and now in the Naval Reserve, and A. V. Roberts of the Chicago Store who is taking a radio course in the Signal Corps at a training school in Maryland.

No grinding machine or grinding attachment should be used without means for changing the work speed

Saw Gumming*(Continued from page 8)***Lap Grinding**

The brazing of a section of saw in an old band saw requires the grinding of the two ends to make a perfect lap.

Entirely too many filers will take an old saw gumming wheel and place it on their lap grinder and then wonder why the wheel will burn the lap. Those wheels are

always too hard and should never be used.

Even though a lap grinding wheel will last anywhere from seven to ten years, it is always more advisable to secure the proper wheel for lap grinding which should be softer than the regular saw gumming wheel.

Before starting this operation this machine should always be given careful attention.

Abstracts from Current Articles Pertaining to Grinding

Salvaging tools in war time. *Machinery*, May, 1918, page 771. This article shows many figures of various grinding machines used in this work and explains the respective operations. Illustrated.

Drill grinding. *Machinery*, May, 1918, page 825. Paper dealing not only with the factors to be considered in grinding drills properly, but showing the effects produced by poor grinding and giving the causes of broken drills. Illustrated.

Truing an emery wheel quickly. *Machinery*, May, 1918, page 832. The writer tells how to true a straight wheel without the use of a vise or fixture to hold the diamond holder. Illustrated.

"Nerco" four-jaw chuck. *Machinery*, May, 1918, page 852. Description of a line of chucks manufactured by the Newark Engineering & Refrigerating Co., Newark, N. J. Illustrated.

H. P. wheel-truing tools. *Machinery*, May, 1918, page 852. Description of several tools made by H. P. Co., 45 Fort St. E., Detroit, Mich. Illustrated.

Automatic slitting saw sharpener. *Machinery*, May, 1918, page 855. A machine made by the Machinery Company of America, 505 Sixth St., Grand Rapids, Mich. Illustrated.

Gaging kink for surface grinding. *American Machinist*, May 2, 1918, page 738.

An operator gages the thickness of steel disks ground on a surface grinder by using a dummy disk measuring to the maximum thickness. Illustrated.

Cutter-grinding gage. *American Machinist*, May 2, 1918, page 759. Mr. Grocock claims the gage should test the radial height of the tips, as well as the radial faces, of the teeth. Illustrated.

Worm gearing. *Canadian Machinery*, May 2, 1918, page 461. Part of this article is devoted to the methods and machines used in grinding worm gears. Illustrated.

New design of shop face grinder. *Railway & Locomotive Engineering*, May, 1918, page 144. Description of a grinding machine recently installed in the Hay-Budden Mfg. Co., Brooklyn, N. Y., who manufacture solid-forged anvils. Illustrated.

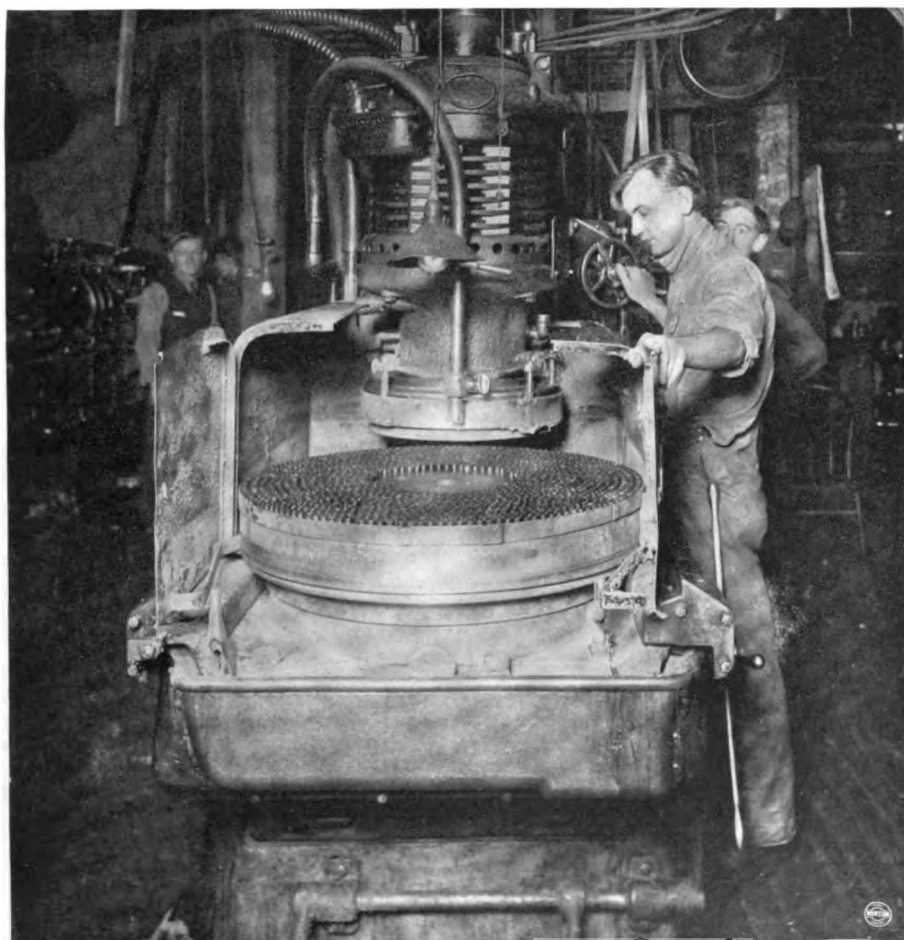
Efficient wheel grinder made from scrap material. *Electric Railway Journal*, May 18, 1918, page 976. Description of a grinder made in the shops of the Springfield Traction Co. Illustrated.

Training instructors according to the Gisholt idea. *American Machinist*, May 16, 1918, page 813. This article outlines fully the course used to train instructors at the Gisholt Machine Co., Madison, Wis. Illustrated.

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GRITS and GRINDS

JULY ——— 1918





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Points on Wheel Selection for the Blanchard Vertical Surface Grinding Machine

BY W. T. MONTAGUE

Size of Wheel

These machines are made with belt drives, in which case $16 \times 5''$, $1\frac{1}{4}''$ or $1\frac{1}{2}''$ rim cylinder wheels are used, or with direct motor drive mounting wheels $18 \times 5''$, $1\frac{1}{4}''$ or $1\frac{1}{2}''$ rim.

Wheel Speed

The belted machines are designed to operate at 1,000 r. p. m., spindle speed or 4,190 s. f. p. m., whereas the motor-driven spindles revolve at 860 r. p. m. or 4,050 s. f. p. m. Tests made by the Blanchard Machine Company proved that this is the best wheel speed to use, slower and faster speeds not yielding as satisfactory results.

Work Speed

On both these machines there are eight table speeds, namely, 5, $6\frac{1}{2}$, $8\frac{1}{2}$, 13, $17\frac{1}{2}$, 22, 29 and 44 r. p. m., which with a 26" diameter magnetic chuck gives approximately a maximum range of from 35 to 300 s. f. p. m. on the work. The most commonly used table speeds are 13 and $17\frac{1}{2}$ r. p. m.

Feed

The vertical down feed of the wheel head can be controlled by hand or by power. The power feed can be varied from .0002" to .005" per revolution of the table by steps of .0002". The most common feed employed is, however, .001" (5 notches on feed wheel). On soft materials or narrow surfaces this can be increased

to .002" and occasionally to .003", although this latter is rare. On hard materials or broad surfaces feeds of .0006" and .0008" are sometimes used. The use of very fine feeds, such as .0002" or .0004" is to be avoided, for they are likely to cause glazing of the wheel.

Wheel Selection

The chief factors to consider when selecting Norton grinding wheels for the Blanchard Vertical Surface grinding machine are:

1. Material to be ground.
2. Width or amount of surface contact.
3. Amount of material to be removed and condition of surface.
4. Finish required.

1. Material. In general, there are two main groups of materials to be considered, namely, the low tensile strength group consisting of such materials as cast iron, chilled iron, brass, aluminum, bronze and fibre. These can usually be ground to best advantage (when Norton wheels are used) with Crystolon wheels bonded by the vitrified process. However, in some cases No. 38 Alundum wheels bonded by the silicate process have given satisfactory results.

The second group is composed of materials of high tensile strength as hardened or soft steel, annealed malleable iron, certain hard bronzes, and so forth. For these metals, No. 38 Alundum bonded preferably by the silicate process is recommended.

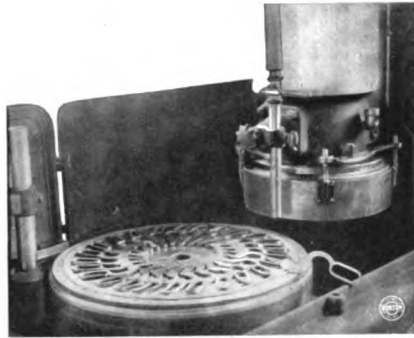


The general rule applying in most kinds of precision grinding applies here, namely, the harder the material, the softer the grade of the wheel. Also use coarser wheels on soft materials than on hard.

2. Width of Surface. The amount of surface as represented by a group of pieces on the chuck must be considered when selecting grinding wheels, not the surface of a single piece. If the pieces pack up closely together on the chuck and form a continuous or uninterrupted surface, then the softer and coarser wheels should be used than for narrow contact. In other words, if the work provides but little clearance for the removal of chips, then we must use wheels that have maximum clearance between the cutting grains.

For narrow, sharp or rough contacts, harder and finer wheels should be used. A 10" or 12" diameter circle in the centre of the chuck should always be left clear of work. **THIS IS IMPORTANT.**

3. Stock to be Removed and Condition of Surface. Coarse wheels cut faster than fine and should be used where much material must be removed, except that on hardened steel and chilled iron the grain depth of cut is limited and wheels coarser than 24 are not recommended. No. 24 grit gives all the room required and



Grinding Levers for Repeating Rifles—steel forgings. Alundum wheel is used

has more cutting points in action than would a coarser wheel.

A rough, uneven surface on castings will usually necessitate the using of a harder wheel than would otherwise be chosen in order to avoid excessive wheel wear. In rare cases, a hard wheel must be used to rough off the high spots and a soft wheel for finishing.

4. Finish Required. On broad and medium width surfaces good finish can be obtained with coarse wheels. Usually the wheel indicated by the first three factors mentioned above will give a sufficiently good finish. On narrow surfaces, as in the case of edges of soft pressed steel cups, boxes, and so forth, it may be necessary to use a wheel as fine as 46. But generally speaking, 36 is only used infrequently and 30 is the usual limit in fineness.

On account of the comparatively large contact between a cylinder wheel and the work, the grinding action of a wheel used on this machine is quite sensitive to a variation of even one grade in hardness. Also the rate of feed seems to be a more influential factor in affecting grinding action than work speed (this is contrary to our experience in cylindrical grinding, where work speed affects wheel speed more than depth of cut). In other words, if a Blanchard cylinder is acting slightly hard, the proper remedy is to decrease the



Grinding Lathe Steady-rest Jaws



work speed and increase the depth of cut. This will tend to break the wheel down faster and hence make it cut freer and act softer. For a wheel acting too soft, the feed should be decreased, if possible, and the table speed increased in about the same proportion.

Although silicate wheels are favored for all classes of steel grinding, it is sometimes necessary to use vitrified wheels in order to meet certain conditions and steels. Whenever there is any question concerning this, comparative tests should be attempted.

The question of whether it is more economical to use hard or soft wheels is always before us. By hard wheels we mean those that give long life but slow cutting action—that have to be dressed frequently. By soft wheels we mean those that require little or no dressing—wheels that free themselves.

We, as wheel makers, have always found much to commend the use of soft, free cutting wheels when final cost is considered, and we are therefore pleased to show the following figures which represent the experience of the Blanchard Machine Company along these lines.



Grinding Shifter Cams—Limits of Accuracy .001

The increased productions assumed for the soft wheel in the above examples are very conservative and would probably in most cases be greater, resulting in a larger saving. The labor and burden rates are

THE ECONOMY OF USING SOFT, FREE-CUTTING WHEELS

Example No. 1			Example No. 2		
	Hard Wheel	Soft Wheel	Hard Wheel	Soft Wheel	
Production per hour,	120 pieces	180 pieces	150 pieces	180 pieces	
Life of wheel,	100 hours	50 hours	100 hours	50 hours	
Pieces ground by one wheel,	12,000 pieces	9,000 pieces	15,000 pieces	9,000 pieces	
<i>Cost per 1,000 pieces ground</i>			<i>Cost per 1,000 pieces ground</i>		
Cost of wheel at \$16.00 per wheel,	\$1.33	\$1.78	\$1.07	\$1.78	
Labor at \$.50 per hour,	4.16	2.78	3.33	2.78	
Burden at \$.80 per hour,	6.67	4.44	5.33	4.44	
	<u>\$12.16</u>	<u>\$9.00</u>	<u>\$9.73</u>	<u>\$9.00</u>	
	9.00		9.00		
SAVING BY USING SOFT WHEEL	\$3.16 per 1,000 pieces		\$7.37 per 1,000 pieces		
	5.12 per day, 1 shift 9 hrs.		1.18 per day, 1 shift 9 hrs.		
	1,536.00 per year, 1 shift		354.00 per year, 1 shift		



also conservative, and an increase in either would materially increase the saving.

The strongest argument for the use of the soft wheel is the increase in production obtained from the same machine and man. Both machines and men are scarce and

difficult to obtain under present war conditions. A manufacturer who uses hard wheels and thereby cuts down production or uses more machines and men to obtain the required production is not only losing money but is slowing up this country's output of munitions.

Let One Man Grind Tools and Keep All The Machines Running

Here are a few interesting thoughts in connection with tool grinding, picked out of the catalog and other literature of a tool grinding machine manufacturer:

Have you ever found two men who could grind the same style of tool and duplicate each other's angles? One of them may be right part of the time; the chances are that there will be a variation.

The man who grinds correctly by hand is more valuable and better satisfied if he is not compelled to quit his own machine every few minutes and spend his time at the grinding machine.

You don't ask a man to run a drill press and grind the drills. Then why should you ask him to run a lathe and grind his tools?

The nearer the tool is forged to the proper shape, the less grinding required.

Grinding High Speed and Self Hardening Steels

If users of the type of tool grinding machines with which a cup wheel is used have trouble with the cracking or checking of high speed steel tools, it is invariably caused by the operator undertaking to keep the tool cool by using water while taking the heavy roughing cuts. This can be obviated as follows:

Have tools rough forged to approximate shape.

Grind tool slowly at first, until tool becomes warmed through, then grinding can be forced without injury to the tool, but do not use water on a roughing cut, as the water will not overcome the heat and will

check the steel. Getting it hot will not hurt it if kept dry.

After rough grinding, return tool to blacksmith and have it tempered. Then return tool to grinder for dressing up and use plenty of water, as with these light cuts, water will keep it amply cool. As tool becomes dull, dress up, using water. When necessary to reforge, proceed from forging as before.

If the above be followed, no trouble should be encountered from the checking or cracking of either high speed or self hardening steel.

Advantages Obtained by Having One Man Grinding Tools and Keeping Toolpost Tools in a Conveniently Located Tool Room

1. No lost time for machines and their operators while tools are being forged and ground, as dull tools are exchanged for sharp ones.

2. Increased machine production, as correctly ground tools cut faster, better and last longer.

3. Increased machine production, as it makes it so simple to get sharp tools that there is no excuse for workmen to use dull ones.

4. Makes the money invested in machinery more productive.

5. Saves from five to thirty minutes per day per man.

6. Makes an annual saving in dollars and cents that will cover the cost of the grinder in a surprisingly short time.



7. Less money is tied up in high-priced tool steel, as a smaller number of tools is required by each man to do the work properly.

8. Provides a systematic way of handling this important factor in your shop.

9. Dull tools accumulate in the tool room and not around the machines.

10. Dull tools go to the blacksmith for reforging in lots, instead of one at a time, making a saving in the smith shop.

11. A low-priced man or boy can grind the tools for an entire shop as well as the best mechanic. Why not use the boy that now grinds your drills, reamers, etc.? He can likely do it along with his other work.

Little Known Facts About Grinding

What Produces Convex or Concave Surfaces in the Grinding of External and Internal Tapers?

By HOWARD W. DUNBAR

It is a well-known fact to every grinding machine operator that in order to produce true tapers, either external or internal, the axis of rotation of the wheel and the axis of rotation of the work *MUST BE ON THE CENTER LINE*. But the reason for this is rarely understood and so for this month's subject the writer will try to explain in a concise and clear way just what happens in taper grinding.

A great deal may be said on this subject. One could write at great length in explanation, which would be no more clearly understood than had nothing been written. We have never attempted nor found it necessary to make a man understand the answer to this question, for the reason that we believe it better to tell him that he must do certain things in order to produce certain results, rather than to make him understand the whys of such a phenomenon. But for the instruction of those who care to study this problem we are offering this explanation.

Referring to the many operators of grinding machines, it is true that probably only one man in a thousand understands this, but it is because they do not have to deal with these problems, and it is sufficient for them to know that in order to produce good work they must observe certain laws and rules. This is a parallel case to the mathematical demonstration of why speed relation of wheel and work have an important bearing on the produc-

tion of ground work. The operators rarely understand grain depth of cut, and have not the time to figure the formulas to determine the relative productibility of one speed and one depth of cut in relation to other factors in grinding. However, it is a mathematical fact that all of these points bear a fixed relation to the amount of metal removed and the resultant increased production in grinding operations. We find it sufficient to tell the operator that the speeds of his work must be regulated until the wheel acts properly, and he involuntarily, from experience, finds where this point is. This we feel is parallel to the instructions we must give operators in taper grinding, namely that the *WHEEL MUST BE ON THE CENTER LINE*.

We know of no machine which in itself has the necessary accuracy which can be maintained indefinitely to produce perfectly true tapers, without the operator's attention in setting the machine up for grinding. Those people using universal machines which do not have such adjustments as a feature of the machine, will regulate this condition by shimming up under the internal grinding attachment for example, using an indicator to be sure that the wheel is on the center line. You will find this a common practice among first-class tool makers. Machines that do have adjustments must naturally be somewhat less accurate, due to the in-



creased possibility of wear and change of relation in parts resulting.

In grinding external tapers one frequently sees an operator put a shim (and by this I mean pieces of bond paper or tissue paper) under the head or footstock, so as to bring the centers in exactly the same plane, and to bring the axis of rotation of work in exactly the same plane with the axis of rotation of the wheel, so that it is not a condition that can be charged to the machine. Machines are made as accurately as they can be made, and for work as nice as that under discussion they must have special treatment in each individual case. This is true in external and internal grinding.

In external grinding the arc of contact at the cutting point between the wheel and the work is relatively small. In internal grinding the arc of contact between the wheel and the hole being ground is relatively large, because it is a common practice in internal grinding to use as large a wheel as is convenient, depending on the size of the hole being ground. This is for obvious reasons, including long life of wheel, larger diameter of the wheel maintaining size for a longer period, etc.

If the wheel is off center in internal grinding, it produces a taper which has a convex surface, and on external grinding a surface which is concave. These surfaces are not true radii. This is magnified in internal grinding because of the fact that the wheel is more nearly the same diameter as the diameter of the hole being ground, thereby causing the wheel to come in contact with the work if off center more quickly than it would in external grinding, in which case the work and wheel are receding from each other. Therefore, the point of contact plays an important part in the amount of error introduced by the wheel being above or below the true center line.

To illustrate this further you can readily understand that if we were grinding an external taper and the wheel instead of being round was a straight line, like an

oil stone (if you can imagine such a condition) mounted on a reciprocating member and moving up and down over the face of the work being ground like a jig saw, it would not matter where the point of contact of the improvised wheel happened to come in relation to the work center, for the reason that a true plane when coming in contact with a true cone will touch it in a straight line, and therefore such a condition would produce a perfect taper.

Because of the fact that in actual grinding practice the wheel is *round* and the work is *round*, and these centers do not happen to be placed in the same plane, the point of contact of the wheel with the work at intervals along the face of the taper changes. As the wheel comes in contact at these different intervals the two faces of the work and the wheel respectively are receding from each other. From the above you will note that the larger the diameter of the wheel used in external grinding the less will be the error which we are discussing.

To illustrate what is happening in a straight taper grinding operation on the external diameter, refer to Sketch "A" in which "1" is the grinding wheel and "2" is the work. You will notice that for the sake of emphasizing the point which we are trying to make we have gone to extremes and placed the wheel 90° from its normal position, bringing it in contact with the work that amount different from the normal practical grinding operations. Now by simply rotating the work in the direction of the arrow you will see that the wheel would cut a radius in the taper. Move the wheel gradually back towards its normal position, rotating the work and attempting to grind the taper, and you will observe that moving the wheel in a direction tending to its normal position will vary the arc ground in the taper gradually and cut more and more until when in its proper position you will grind a straight line. Of course, it is understood that at the same time the work is rotated

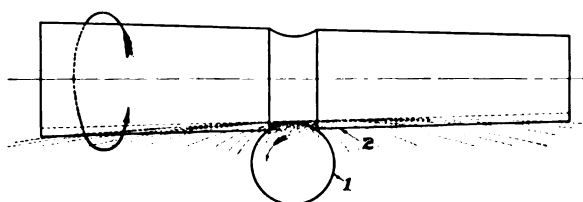


Fig. A

the travel of the wheel on its ways is parallel to the wheel spindle.

Please bear in mind that we are assuming in all of these demonstrations that the diameters of the large and small ends are being maintained to correct dimensions. This is for convenience in illustrating more emphatically what is happening under these conditions between the large and the small end. Regardless of whether you do or do not maintain your dimensions correctly the same error is introduced. This is also true in all of the illustrations to which we make reference in this article.

In the sketch the dotted lines indicate varying degrees of concavity, due to the working of this phenomenon, and if you will study the sketch carefully, although it is difficult to explain, you will see just what we are driving at. The concavity becomes less and less until the axis of the grinding wheel comes to the same plane as the axis of the cone, when the concavity disappears and the line becomes straight or of an indefinite radius.

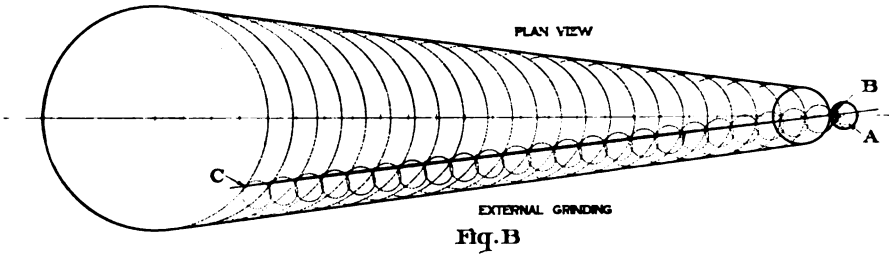
In Figure "B" to illustrate this point further, we have shown diagrammatically what occurs in the grinding of a taper where the spindles do not lie in the same plane with each other. To emphasize this difference still more we have gone to an extreme case for the reason that the error produced by a very slight amount of out of plane is not perceptible to the eye, although very marked when tested in the manner that tapers are usually tested, namely in a lap of the proper taper.

In the case of the diagram the taper has

also been made extreme. The grinding wheel is shown by the letter "A" and we have indicated by dotted circles along the taper units of distance between the extreme point of contact at the small and large ends. At the small end it is indicated at "B"; at the large end it is indicated by "C," and dots are shown between these two points "B-C" showing points of contact at regular intervals along the taper. A line drawn from point "B" to point "C" produces a straight line. A line drawn connecting all of the points of contact at the various intervals along the taper produces a curved line, which illustrates the condition we are trying to describe.

Each interval along the taper shows that the point of contact is constantly approaching the point where it is more nearly in plane with the center of the grinding wheel and the center of the work. The center of the wheel as it travels along the taper, of course, always travels in a line parallel to the edge of the taper, but the constantly changing diameter of the taper accounts for this change in the point of contact.

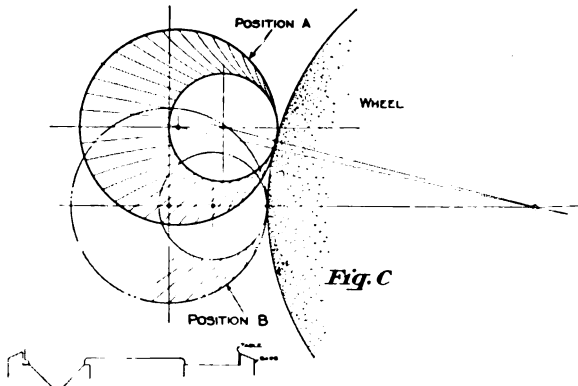
To illustrate this phenomenon still more clearly diagram Figure "C" has been made, which is an end view of taper grinding in which we have shown two positions of the work in relation to the axis of the wheel. Position "B" is the correct position for grinding a true taper. Position "A" is the incorrect location of work relative to the axis of rotation of the wheel. Position "B" is correct for the reason



that only when the center of the large end and the center of the small end, the point of contact and the center of the wheel all lie in the same plane, and position "A" illustrates that when *ONE OR MORE OF THESE POINTS LIE OUTSIDE OF A PLANE IT IS IMPOSSIBLE TO GRIND A TRUE TAPER.*

The surface speed of the work is dependent on two factors: the speed of revolution of the work and the diameter of the work being ground. The small end of the taper has a smaller surface speed than the large end, for the reason that it has a smaller diameter. Each unit of distance along the taper has a corresponding variation in the surface speed because of this same fact, even though it be rotating at the same number of revolutions per minute.

In most taper grinding, however (when we think of taper grinding we think of the standard tapers like the Morse or Jarno taper), the change in diameter from end to end of standard tapers is so small as to be neglected in the cutting action of the wheel. So that for all practical purposes in such grinding we do not figure that the taper is of sufficient importance to be a consideration in the cutting action of the wheel. If we had such work as is represented by the extreme condition which is illustrated in the diagram this change in diameter would become a factor and your wheel action would be affected sufficiently to become a consideration. The remedy for such a condition would be the use of a soft wheel and an increase in time in performing the operation.

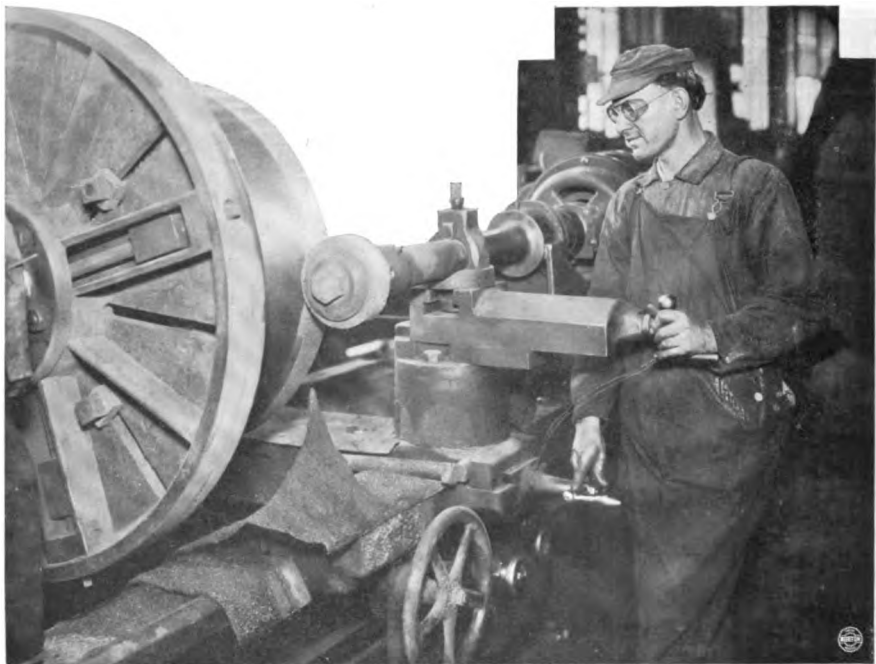




GRITS and GRINDS



This is a finish grinding operation on the flange ways of manganese street railway tongue switches. Because of the narrow surface to grind, it is necessary to use special hand grinders. Wheels usually used are 10 x $\frac{1}{4}$ ", grain 20, grade P Alundum and are driven at about 1800 R. P. M.

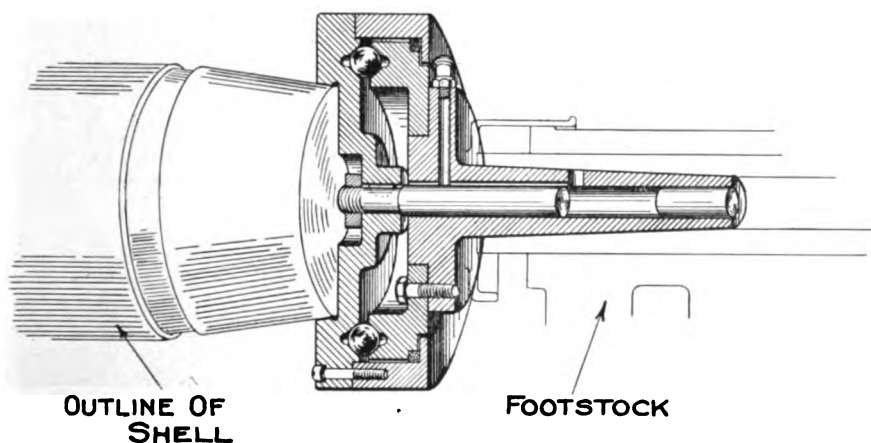


Grinding a manganese steel bushing externally (and internally) on a heavy lathe. An Alundum Wheel is being used, 14 x 2 $\frac{1}{2}$ ", grain 14 grade P. It is operated at 1800 R. P. M. and has to remove $\frac{1}{4}$ " of steel from each surface

Grinding Kinks

Live Footstock Center

By HOWARD W. DUNBAR



We are illustrating above a finished form of a ball bearing center for footstock use in the production of large work, particularly of the type ground in munition plants, such as projectiles and shells. As the illustration shows, this makes a convenient form of simple construction to handle this character of work, and is sufficiently clear in its construction to

require no explanation.

There is just one point that should be impressed upon those who attempt making such a device, and that is that the ball should be connected as far away from the center as convenient, depending on the size of the work being ground. This gives a better thrust and a smoother rotation.

No two pieces of steel are exactly alike; it is probable that the variation of material the wheel grinds is as great in its effect upon the results as are the variations from exact grade of wheel.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Radius Truing Fixture for Use on Grinding Wheels. American Machinist, May 23, 1918, page 885. Describes this fixture which has been successful and is claimed to be simple in construction and more economical than many in common use. Illustrated.

Nelson Boring and Grinding Attachment for Lathes. American Machinist, May 30, 1918, page 929. A combination boring-bar and grinding wheel attachment for use on lathes and shapers, now being marketed by the Nelson Tool Co., 1605 West Lake St., Chicago, Ill. Illustrated.

Example of Precision Gage Making. Machinery, June 1918, page 878. Methods of making and testing when unusual accuracy is required. The most important part is grinding the angular arms of the gaging blocks. Illustrated.

Holder for Grinding Accurate Thread-cutting Tools. Machinery, June 1918, page 925. The tool is fastened in a block mounted on the magnetic chuck of the surface grinder. This method is used by the Blair Tool and Machine Works, Inc., 515 Greenwich St., New York. Illustrated.

Manufacture of Grinding Wheels. Purchasing Agent, April 1918, page 106. Abstract of an address by the Research Engineer of the Abrasive Company, Philadelphia, Pa. Illustrated.

Eight and One-half Inch Ring Grinder. American Machinist, European edition, February 2, 1918, page 176E. Made by Harry F. Atkins, Old Fletton. Illustrated.

Multiple-roll Gear Chuck and Formulas for Grinding Holes in Gears. American Machinist, June 6, 1918, page 947. Illustrated.

Grinding Practice. American Machinist, European edition, January 26, 1918, page 170E. The writer discusses lubri-

cation, belting and driving power, and the balancing of grinding wheels with the aim of showing how waste of essential material may be avoided. Illustrated.

Shop Training School for Employees. Manufacturers' News, June 6, 1918, page 15. J. C. Spence's brief but comprehensive account of the training department of the Norton Grinding Company, explaining very clearly the reasons for its existence.

Machinery Company's Slitting Saw and Circular Knife-grinding Machines. American Machinist, June 13, 1918, page 102. The Machinery Co. of America, Grand Rapids, Mich., has developed a bevel grinding machine for circular knives and cutters. Illustrated.

Alundum: Artificial vs. Natural Abrasives. Metal Industry, June 1918, page 278. This article by Mr. Fritts tells how and why the use of alundum and artificial abrasives in general has increased in the polishing trade during the last decade. Illustrated.

Polishing and Finishing Machines. Canadian Machinery, June 13, 1918, page 627. A description of one type of machine developed by the Blevney Machine Co., Greenfield, Mass., which makes polishing machines with the two-belt system of finishing with an abrasive cloth belt running at high speed over a heavy corrugated leather cushion belt. Illustrated.

Swege and Automatic Grinder. Woodworker, June 1918, page 37. In this article the writer explains some of the difficulties encountered in grinding saws and tells how to overcome them. Illustrated.

Training Men Instead of Stealing Them. American Machinist, June 20, 1918, page 1035. This paper consists chiefly of an account of the Training department of the Norton Grinding Co. Illustrated.

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Choosing Wheels for Pratt & Whitney Vertical Surface Grinding Machine

BY P. A. BRIDGMAN

The Pratt & Whitney Company manufacture two models of vertical surface grinding machines, the 36" and the 22".

The former is named from the length of its working table, the latter from the size of wheel used; a 22 x 4 x 17 $\frac{3}{8}$ ".

The 36" machine takes a wheel 14 x 4 x 10 $\frac{3}{8}$ ".

These machines handle either plain or circular grinding and are equipped with various appliances which, by adjustment, permit a wide range of work.

One feature particularly brought out by the manufacturers of this machine is its ability to handle either plain or circular grinding with the same degree of efficiency. The working surface on the table of the 36" machine is 11 $\frac{3}{8}$ x 36", while the 22" machine has two tables, one 18 x 48" and the other 18 x 34". A single rotary magnetic chuck 16" in diameter, allowing work 4" in thickness to be ground, and a rectangular magnetic chuck 7 $\frac{1}{4}$ x 31", allowing work 10" in thickness to be ground, may be used on a 36" machine.

On the 22" machine a single rotary magnetic chuck 24" in diameter, a duplex rotary magnetic chuck 18" in diameter and a quadruplex rotary magnetic chuck having four tables 14" in diameter may be used.

The recommended speed per minute of the wheel on the Pratt & Whitney vertical surface grinding machine is 4,350 surface feet.

[2]

The wheel feed may be either by hand or automatic. Water or grinding solution is supplied on the inside of the cylinder through the driving shaft and externally by means of a pipe; the wheel is belt driven and the spindle is of the ball bearing type.

The same general conditions hold in connection with wheel selection for the Pratt & Whitney machines as hold with machines of similar model, special attention being paid to the material to be ground, the amount of material to be removed, the condition of the surface and the finish required.

With the choice of wheels for these two models, the matter of material to be ground first presents itself.

The machine is sensitive, the same rule holding true as in other grinding of precise nature, the harder the material to be ground the softer the grade of wheel; the softer materials requiring coarser wheels.

Local conditions, to be sure, will sometimes effect slight deviations from these rules.

To illustrate: it may be an operator's persistent preference for a certain grade of wheel, or it may be surface conditions of material to be ground, where too pronounced fins, gates or sprues make a harder wheel than usually recommended, more

[August, 1918]

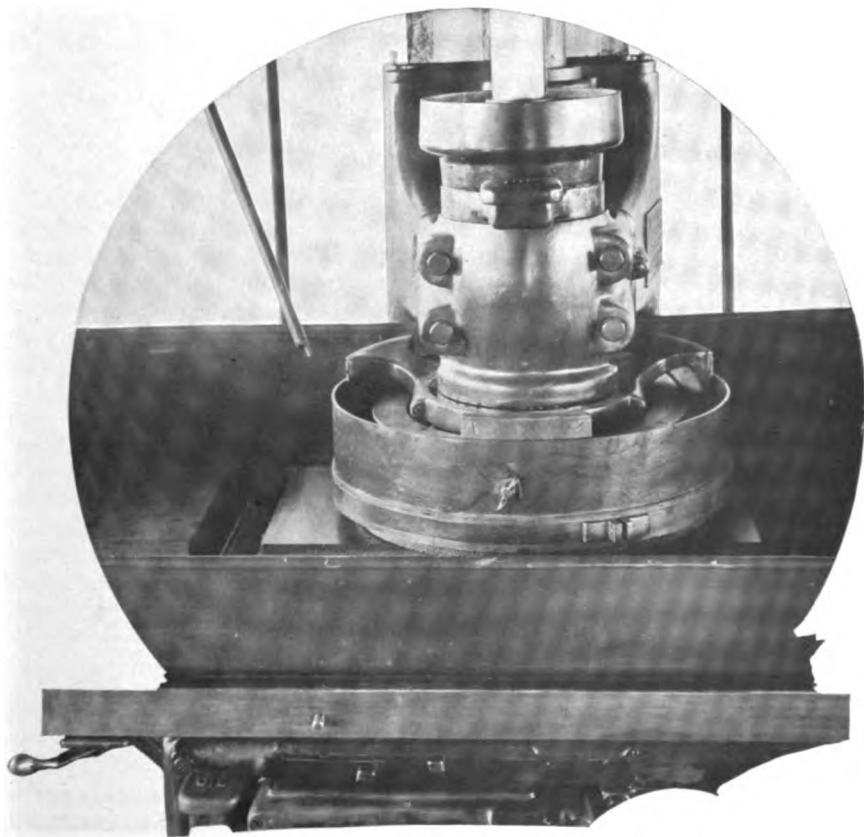
economical from the standpoint of wheel wear. In a broader sense, however, from a varied experience and exhaustive tests with Norton wheels on Pratt & Whitney vertical surface grinding machines, specific rules may be suggested which permit of very little change. It is admitted that, owing to the broad contact between the cup wheel and the work, there seems to be a more sensitive relationship existing than in any other kind of grinding. So much so, in fact, that the effect of the slightest change in the grade of a wheel or in the rate of feed records itself in the work at once.

What holds true with other vertical surface grinding machines is also true of

the Pratt & Whitney, that is, if the wheel is acting too hard this particular difficulty may be overcome by decreasing the work speed and increasing the depth of cut, a measure just opposite to that usually employed under similar circumstances in cylindrical grinding.

Another interesting feature in connection with choosing the proper wheel lies in the wheel's physical make-up, each grain, a cutting tool in itself, requiring the usual clearance given any machine tool.

If these grains are too closely bonded, provision must be made in the arrangement of the work so that this will allow for the clearance. On the other hand, if, in loading the magnetic chuck, the pieces





to be ground are placed closely together, the wheel should be a soft and coarse one.

When gaps between the material on the chuck are present a finer and harder wheel is more effective.

Following is a brief list of wheels which have proved themselves satisfactory where the present day call is for increased production:

Crank cases for Liberty motors

3824—H—Alundum Silicate

Automobile parts 3830—L—Silicate

Surfacing hardened steel

3830—I—Alundum Silicate

Brass castings 24—I—Alundum Vitrified

Surfacing tops and bottoms of cast iron cylinders, 20—G—Crystolon Vitrified

Surfacing breech blocks

3820—J—Alundum Silicate

Surfacing steel washers

3824—I—Alundum Silicate

The Cost of Snagging

A Mathematical Analysis of the Cost of Foundry Snagging

By LEON L. KATZENSTEIN

Several years ago the Federal Trade Commission of the United States investigated the manufacturing industries of this country and found that the lack of adequate cost records was the most common weakness of American industries. Our entrance into the war with its attendant change in production and taxation of profits has further shown the importance of knowing in terms of dollars the results of any change in the making of goods. Cost figures, furthermore, when properly arranged are a reliable indication of the intelligence with which the engineering problems have been solved. Because although Power, Material and Human Effort are not interchangeable they have, nevertheless, a common monetary value.

The determination of costs for the grinding of castings and billets has advanced with the growth of the iron and steel industry, but the simplicity of this operation in comparison with the more complicated processes of the foundry has been such that there was little opportunity for a detailed analysis. An effort has, therefore, been made to express the total cost of grinding in terms of quantities which are related to the physical properties of the abrasive structure and to the

basic elements necessary to the execution of the work. The large number of quantities which must be considered, however, can be most easily discussed by means of a mathematical equation because it is desired to investigate the relationship for any set of operating conditions in order that the laws deduced may not only show the way in which the grinding cost will vary but also the relative importance of each factor.

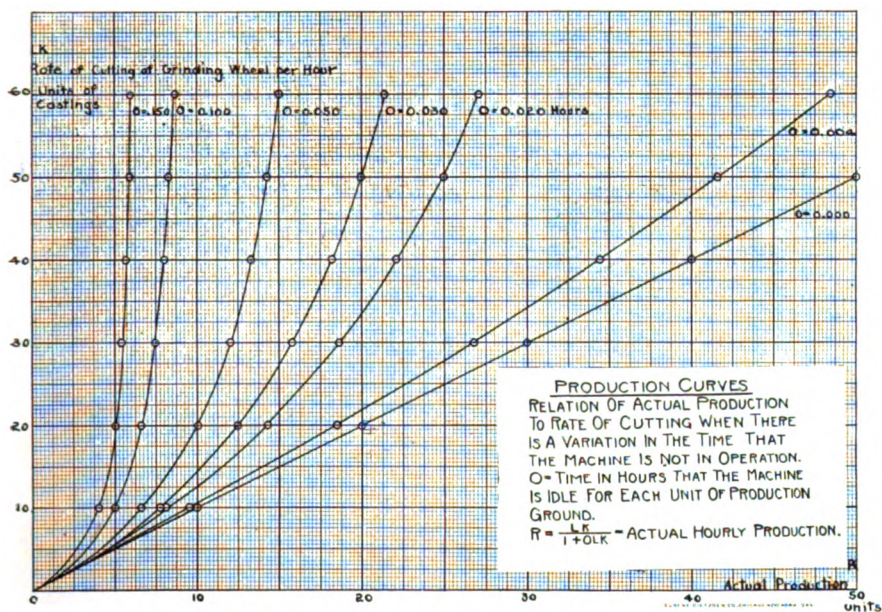
Suppose that every quantity is designated by a letter according to the following table.

1. P is the total grinding cost in cents of each unit of product ground. It does not make any difference as to the nature of the unit whether it is tons, pounds or pieces as long as the entire output is considered in the same way.

2. A is the net cost of the grinding wheel laid down in the foundry. This is the only item of expense which is affected by the selling price of the abrasive product.

3. B is the price received for each grinding wheel stub and is usually a very small amount.

4. H is the volume in cubic inches of the grinding wheel dressed away for each



If operators are paid by the day they are apt to do just a given amount of work. The variation in the output with a faster or slower cutting wheel may be as dependent upon the quality of the supervision as upon the action of the grinding wheel. If the piece rate system is in use, then there is a greater tendency for the time of inaction to remain constant, although the fear of having the earnings too large and hence causing a reduction in the piece rate or the desire to exaggerate the decreased cutting ability of a harder wheel may cause the operators to increase the time the machine is not producing.

8. L is the number of grinding wheels on each machine. This usually is either one or two, although there are some planer types of surfacing machines which have a larger number.

9. K is the rate of cutting in units of product per hour of each wheel. This quantity is difficult to determine and may be expressed by tons weight, number of pieces ground or amount of metal removed. The rate of cutting of the grinding wheel should not be confused with the rate of production, which depends upon O and which is the amount of grinding actually accomplished. The rate of cutting K is a property of the grinding wheel imparted by the wheel maker and depends upon the abrasive structure.

10. Q is the sum of the maintenance and overhead charges and consists of Supervisory labor, Maintenance labor, Maintenance supplies, Rent, Interest, Taxes, Depreciation, Insurance, and Heat, Light and Power. This expense, depending upon operating conditions, equipment and location varies from \$0.10 to \$10 per machine per hour.

11. C is the basic hourly labor rate for grinding operators. If more than one operator is required, then the labor charge is the total of all employed at each machine. The piece rate is based upon an

hourly rate and the earnings are permitted to vary only as they are in accord with the general price of labor.

12. M is the number of men required to each machine. It has been the practice in some foundries to furnish each grinding operator with a helper, but this is nearly obsolete now.

13. G is the grinding capacity of the wheel and if no dressing occurs, then the grinding capacity may be measured by hours life, otherwise by tonnage, number of pieces ground, or the amount of metal removed. The grinding capacity is the other property imparted by the wheel maker and for any given set of operating conditions varies only with the abrasive structure.

If each wheel is capable of grinding K units of product and if there are L wheels mounted on the machine the total output will be LK units of product for each machine per hour. Therefore the time to grind one unit of product per machine is $\frac{1}{LK}$. The grinding wheels, however, are not working continually because the operator must move the casting and possibly perform other duties. This period has been called O hours. That is, for every unit of product ground there are O hours during which the machine is not in operation; hence the total actual time required to grind one unit of product is $\frac{1}{LK} + O$. Therefore the production per hour per machine is $\frac{LK}{1 + OLK}$ units.

The maintenance and overhead charges per hour for each machine is Q dollars; therefore the maintenance and overhead charges for each unit of product is Q divided by the hourly production of the machine or $Q(1 + OLK)$ dollars.

The total cost of operating labor per hour for each machine is equal to the number of men engaged on each machine times the labor rate per hour or CM dollars. Therefore the labor cost per unit



of product is $\frac{CM(1+OLK)}{LK}$.

The grinding capacity of each wheel is G units, or if the grinding wheels are dressed it is equal to $\frac{J}{H+I}$ units. The net cost of each grinding wheel is the purchase price of the wheel minus the selling price of the stub or is equal to $A-B$ dollars. Therefore the cost of the abrasive material per unit of product is $\frac{A-B}{G}$ dollars or if the wheel is dressed it may be expressed as $\frac{(A-B)(H+I)}{J}$ dollars.

The overhead, labor, and material expenses have now been determined per unit of product and the total cost is therefore the sum of these or $P = \frac{A-B}{G} + (Q+CM)\frac{(1+OLK)}{LK}$ and if dressing occurs, $P = \frac{(A-B)(H+I)}{J} + (Q+CM)\frac{(1+OLK)}{LK}$.

As a general rule there are only one operator and one grinding wheel to each machine, then

$$1. P = \frac{A-B}{G} + (Q+C)\frac{(1+OK)}{K}$$

The facts stated by these equations are that the total cost of grinding each unit of product is equal to the sum of the expense of material $\left[\frac{A-B}{G}\right]$ or $(A-B)\left(\frac{H+I}{J}\right)$, of labor $\left[C\frac{(1+OK)}{K}\right]$, and of overhead $\left[Q\frac{(1+OK)}{K}\right]$, and that the real output of each machine, on account of the delays which accompany industrial production, must be corrected by the factor $\frac{1}{1+OK}$, sometimes called the Operating Efficiency, which is always less than one and whose value depends upon the time the machine is actually producing.

The mathematical form, however, is of assistance to indicate how certain elements, such as the abrasive structure and machine equipment, may be varied in order to have the cost as low as possible when unavoidable changes occur in other factors. From the equations it is apparent, for instance that:

1. The only reliable way to determine grinding costs is to keep a continuous record of all the contributing factors of expense.

2. It is economy to maintain the

grinding equipment in good condition because the saving in depreciation and increased output is greater than the expense of maintenance.

3. An endeavor to approximately determine the variation in cost by computing the percentage change in each item of expense which might occur with a change in equipment or grinding wheel is very misleading because the factors are applied to quantities which are apt to be of entirely different magnitude. A contemplated change may increase the wheel cost 10 per cent. and reduce the labor and overhead 3 per cent., but the value of the abrasive consumed per unit of product may be \$0.10 and that of labor and overhead, \$0.95. So that in spite of the increased percentage cost it would be economy to make the proposed change.

4. The lower the labor and overhead expense, the greater the saving obtained by using a hard acting, slow cutting abrasive structure.

5. When the cost of abrasive material remains constant and that of labor and overhead is increasing (as under the present war conditions), the greater economy is obtained by securing a soft acting, fast cutting abrasive structure.

6. Every effort should be made to reduce the time per unit of product that the machine is not producing, and little is gained by using a faster cutting wheel as long as this period is permitted to remain unnecessarily long. For it may be seen from the Production curves that relatively small periods of inaction of the machine greatly reduce the amount of grinding from that which the abrasive structure is actually capable.

7. It is wrong to neglect maintenance and overhead expense or to assume it is a given amount, because it is usually greater than one supposes and its size affects the method of procedure which is conducive to the greatest economy.

8. The possibility of reducing the cost of snagging by reviewing what is available and that which is required depends upon the detail and care taken in the accumulation of data pertaining to each factor of operation.



Little Known Facts About Grinding

Soft Wheels

By HOWARD W. DUNBAR

It is difficult for the grinding machine engineer to refrain from constantly hammering at an old subject. The reason for this seems to be that usually there is a considerable difference of opinion between his thoughts and the user's thoughts on such subjects.

Having had this quite strongly impressed upon the writer's mind while visiting certain shops during the past month, it seems wise at this time to again bring up for consideration the question of soft wheels.

Normally, in most grinding departments, the tendency both on the part of the grinding machine operator and his foreman is to use harder and harder wheels. The reason for this seems to usually come from the feeling on their part that because the wheel lasts longer it is naturally a more economical wheel to use. This is unquestionably a mistaken idea. Wheels are only an economical proposition when they do wear out. Now do not draw a wrong conclusion from this statement, because there is a wide difference between wheels wearing out and producing a large number of parts and those that wear out with a small production.

Soft wheels are only relatively soft. So to assume because a wheel is on a low scale in the grade list that it is a soft wheel is incorrect reasoning because it can only be soft to the grinding engineer's mind when it is free enough to cut rapidly and in order to perform in this manner it must be soft. The grade list is merely a means for identifying certain kinds and types of wheels so that they may be readily reproduced.

The degree of softness or hardness of the wheel is best determined by its cutting

action, its productibility and performance rather than by the position it occupies in any particular grade list. To go a bit beyond the usual understanding of a soft wheel, one must take into consideration the type of machine that the wheel is to be used with, the kind of material that such a wheel is to grind, the mechanical dimensions of the wheel itself as related to the dimensions of the work it is to grind. To illustrate: A wheel of a given diameter and width of face performing a grinding operation upon a piece of hardened tool steel 2" in diameter acts in grade (which means its degree of softness or hardness), quite differently than it would were it grinding upon a piece of the same steel 4" in diameter. This, to the grinding machine engineer, is logical reasoning because in the two cases cited the arc of contact is different, and the arc of contact, width of face of the wheel and radial depth of cut are factors which cause a wheel to act either hard or soft.

I have often had occasion in talking with some operator in a grinding department who felt that he was more or less in trouble because his wheel was wearing out rapidly or glazing and filling, and he could not produce the large number of pieces per day that he had hoped, to receive in reply to my question, "Have you used a soft wheel?" the answer, "Oh, yes, this wheel is a K wheel." In his mind that wheel was soft because it occupied the position in the low scale of the grading list. He had given little thought to the fact that he was grinding work eight, ten or twelve inches in diameter. In each case the K wheel might have been quite a bit too hard for the operation and again undoubtedly he had paid little attention to the fact that his



speeds of work revolution could be of so great assistance to him in causing that wheel to act in a proper manner.

When considering wheel grades to determine the correct one to use, the following points should be kept in mind.

1. That the grade letter has little meaning in so far as the wheel action is concerned, it only serving as the means of identifying that particular wheel.

2. The diameter of the work will vary the cutting action of the wheel. The smaller the work the harder the wheel may be and the larger the work the softer it must be, of course, assuming that the diameter of the wheel is the same.

3. The larger the diameter of the wheel the harder the wheel will act. The smaller the diameter of the wheel the softer it will act, the diameter of work remaining the same in both cases.

4. The wider the face of the wheel in contact with the work being ground, the softer the wheel must be to grind rapidly.

5. Work speeds are provided for the purpose of varying the cutting action of the wheel; in other words, so that the wheel may be made to act soft or hard.

6. The grain size affects the apparent grade of the wheel, finer grains appearing hard while coarse grains appear soft in

their action, regardless of the bonding grade.

After all, even though the tendency be in the direction of hard wheels to-day, and when we say hard wheels we mean harder than necessary to perform a given operation, the day will come when operators will realize that life of wheel is a secondary consideration, that the number of pieces ground is of prime importance and there can be no question as to the productibility of soft acting wheels as compared with one that is hard, requiring frequent dressing to keep its face open enough to grind rapidly. It probably is a fact that 75% of the defects in grinding operations can be charged to the use of too hard a wheel. Chatter marks are produced by a hard wheel. Hard wheels generate more heat in the grinding operation which changes the shape of the pieces being ground and makes more difficult the possibility of round work. Hard wheels fill and glaze, causing blemishes in the finish. Hard wheels won't "bite," as the grinding machine operator would say; that is, they do not cut freely. Hard wheels require infinitely more power, at the same time accomplishing less work. Hard wheels cause abuse to the machines, principally the spindle bearings. Hard wheels are the bugaboo of every grinding department.

With the cylindrical grinding machine we can produce a cylinder that will measure "to exact limitation" and with "strict conformity to a rule or standard." The limitation, when required, can be so much smaller than when using the lathe that the cylindrical grinding machine is rightly known as the precision machine.



“Tony” Clark Who Puts the Grin in Grind

If “Tony” Clark could write this brief sketch of himself, it would doubtless be far more entertaining if less accurate than the one which is herewith submitted.

For whatever other traits or characteristics he may have, he certainly has a keen wit and a ready pen. And since it is possible sometimes to reason from what is not said as well as from what is told, it is apparent that Tony's career has been one step after another up the ladder of business achievement and responsibility.

He says he was born in Kansas about thirty years ago, but as soon as he discovered where he was, he moved his family to Indiana. An educational training which ended with a diploma in engineering at Purdue University, and the game was on. A little over a year was spent in Cuba and then he returned to the U. S. A., and entered service with the Oliver Chilled Plow Works at South Bend, Ind., as draftsman and designer. He worked for them in various capacities, finally becoming chief draftsman of their plant at Hamilton, Ontario.

He then entered the selling game, for two years and a half travelling through Canada with a line of machine tools. “By this time,” he says, “all the machine tool buyers were on to me.” So he went back to the Oliver Company as engineer. Modesty and pleasantry cannot so easily conceal his steady progress.

In 1916, the Norton Company recognized his value and sent him to Worcester for a three months' special course, since which time he has been connected with the Chicago office as special railroad representative for the company. He wanders at will west of Pittsburgh and all over Can-



H. K. CLARK, Chicago, Ill.

ada, spreading the knowledge of Norton grinding in the railroad shops, a big job which he handles in a big and efficient way. He apparently considers his penchant for jokes as detracting from his personal dignity—and as concealing his devotion to his work, but the editor ventures the opinion that “Tony” Clark in his rôle of Raymond Hitchcock and “Chimmie Fadden” and Mr. Dooley combined, is about the most welcome and popular salesman that walks into any office. And we also are convinced by figures as well as our knowledge of human nature, that his keen sense of humor and his normal and well-balanced perspective combined with his thorough and scientific knowledge of his work, make Tony Clark one of the real assets of the Norton organization.



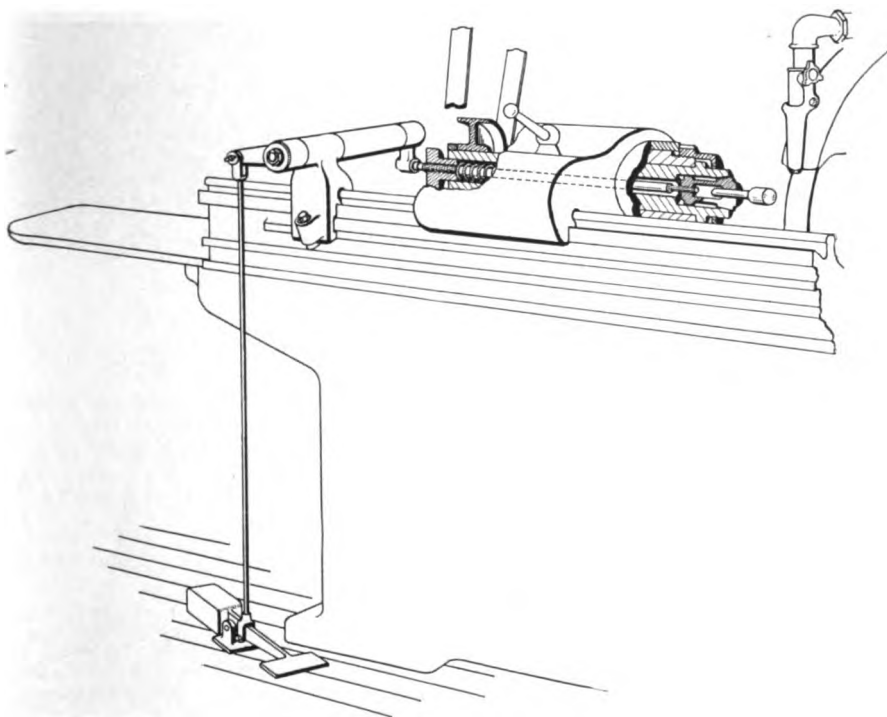
Grinding Kinks

Foot-operated Live Spindle Attachment

BY HOWARD W. DUNBAR

The accompanying illustration pictures a device for controlling the chuck in a live spindle attachment used in chucking and releasing work by means of a foot pedal. The details of construction need no further explanation; the foot pedal merely being a connection replacing the hand wheel and

commonly employed on this type of attachment. The advantage lies in the convenience afforded the operator in handling small parts for grinding, where the grinding time is comparatively short, leaving both hands free to insert or remove work from the machine.





Abstracts From Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Lafayette Tool-grinding Jig. American Machinist, July 11, 1918, page 91. Illustrated. This device is made by the Lafayette Tool Works, 176 Worth St., New York, N. Y.

Grand Rapids Drill-grinding Machines. American Machinist, July 4, 1918, page 44. Illustrated. Two of the new lines of drill-grinding machines marketed by the Grand Rapids Grinding Machine Co., Grand Rapids, Mich., are described.

Grinding Hardwood Matcher Cutters. Wood-worker, July, 1918, page 37. Illustrated. A very brief article illustrating the method of grinding cutters with an "American" grinder.

Grinding Wheel Contact and Wheel Grinding. American Machinist, European Edition, June 29, 1918, page 109E. Illustrated. The writer discusses in this article the limitations and modifying conditions influencing the general theory of contact which states that the broader the contact the softer the wheel required.

Hollow-grinding the Tooth Face of Gear Cutters. American Machinist, July 25, 1918, page 152. The writer describes his method of performing the operation mentioned.

Polishing Inside Profile of Nose on High-explosive Shells. American Machinist, July 25, 1918, page 168. The writer of this article tells how a small, round Alundum stone is used in this work.

Coates Universal Tool and Cutter-grinding Machine. American Machinist, July 25, 1918, page 175. Illustrated. Description of a machine marketed by the Coates-Kendall Corporation, 50 Church Street, New York, N. Y.

Thompson Universal Tool and Cutter-grinding Machine. American Machinist, July 25, 1918, page 180. Illustrated. Description of a new machine marketed by the Thompson Grinder Co., East Main and Murray Sts., Springfield, Ohio.

Grinding Index Head Centers. American Machinist, August 1, 1918, page 202. Illustrated. The illustration shows the method used for re-grinding the centers of the dividing head when they have been worn.

Grinding Six-inch Shell-boring Cutters. American Machinist, August 1, 1918, page 207. Illustrated. Description of a fixture used successfully by the Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Ont., Canada.

Persons-Arter Sixteen-inch Rotary Surface-grinding Machine. American Machinist, August 1, 1918, page 223. Illustrated. Description of the latest product of the Persons-Arter Co., Worcester, Mass.

Non-calipering Drill Grinding Machine. Iron Age, August 1, 1918, page 281. Illustrated. This machine is made by the Grand Rapids Grinding Machine Co., Grand Rapids, Michigan.

Efficient Appliances for Economic Shell Production. Canadian Machinery, August 1, 1918, page 144. Illustrated. Three devices used in the grinding of shells are described in detail in this article.

"All-angle" Grinders Brought out and Made in Toronto Factory. Canadian Machinery, August 1, 1918, page 148. Illustrated. A comprehensive description of a new universal grinder built by the Toronto Type Foundry Co., Toronto, Canada.

Traverse Motion for Grinder Carriage. Machinery, August, 1918, page 1136. Illustrated. Description of a mechanism for controlling the traverse motion of the carriage on a grinding machine.

Fraser Universal Grinding Machine. American Machinist, August 8, 1918, page 270. Illustrated. Description of a new universal grinding machine marketed by the Warren F. Fraser Co., Westboro, Mass.

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GRITS and GRINDS

Sept.



1918



**Snagging Steel Castings with an Alundum Wheel on a
Swing Frame Grinding Machine**



Grits and Grinds

Vol. X September, 1918 No. 4

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Factors that Affect the Efficiency of Snagging

By LEON L. KATZENSTEIN

Snagging may be defined as the grinding of a given mass of metal to approximate form and with little consideration for the appearance of the ground surface. This operation differs from precision grinding in that the object is merely to remove a large amount of material as economically as possible.

Grit and Grade of the Grinding Wheel

A snagging wheel consists of thousands of small cutters which may vary from one-eighth to one-sixty-fourth of an inch in size and which are made of a hard, tough, sharp fracturing material which is called abrasive. These particles are so bonded together as to produce structures of varying hardness in order to efficiently serve the needs of various metals and machines. A grinding wheel of vitrified bond and of a given type of abrasive is therefore completely described when the size of the abrasive particles and the hardness of the structure are stated. The size of the abrasive is designated by a number which represents the number of meshes per inch of screen through which the particles will pass and the hardness is classified by letters of the alphabet so that there will be no uncertainty as to which quantity each refers. Grade Z is the hardest.

The structure of a vitrified snagging wheel is quite porous, thus forming a large number of cutting edges as well as clear-

ance spaces for the lodging of chips as the abrasive grains penetrate into the metal. An absolutely solid material with no interstices between the abrasive particles would not be a very satisfactory cutting tool under ordinary operating conditions. The need, however, of large abrasive grains and a very porous structure is often not as great



In this diagram each numbered area represents an equal volume of the grinding wheel structure, and as the center of the wheel is approached it may be seen that the thickness of each equal volume rapidly increases. It is therefore evident that there will be an increasingly rapid reduction in the diameter as the wheel becomes smaller.

as many imagine. Grinding wheels of finer abrasive and softer grade cut smaller individual chips but the number removed



per revolution of the wheel is much greater and the total volume of metal is not always less, as some believe, and may be considerably greater. The wheel wear can also be reduced because it is possible for the particles to break away in smaller pieces. This is especially true in the surfacing of billets and in the grinding of alloy metals which cannot be conveniently cut with the ordinary machine tools.

Judging the Grinding Action

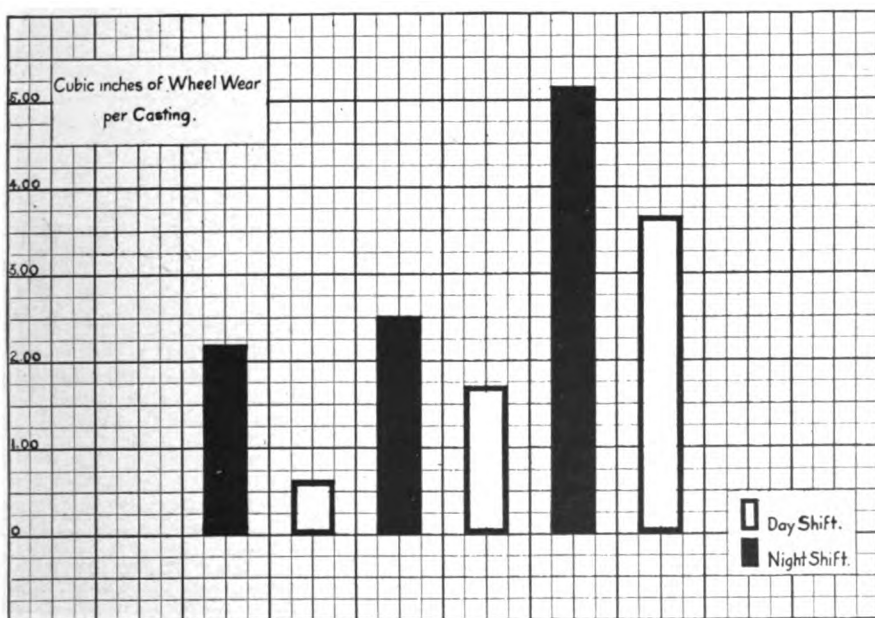
Because of so many unavoidable variations in the size and structure of the casting or billet it is a difficult task to determine the relative merits of snagging wheels. But the only reliable criteria of the suitability of an abrasive structure are the rate of cutting and the amount of

abrasive material worn away per unit of volume of metal ground. Any other basis of selection is an approximation for these two quantities, and experience has shown that even the opinion of expert grinding operators is subject to many uncertainties unless supported by actual data on the rate of cutting and the grinding capacity.

Importance of Operating Conditions

In fact if these data were daily collected for a long period of time it would be seen that the action of a snagging wheel is very sensitive to any variation of the following conditions:

1. The manner in which the grinding wheel is applied.
2. The speed of rotation.



In this diagram we see the effect of some of the factors mentioned above. The figures represent results obtained on three consecutive days and nights in a foundry grinding drawbars. In this particular test it will be noted that the night shift was more wasteful of abrasive than the day operators. Also, the consumption of abrasive per casting ground increased each succeeding day. This merely illustrates how wheel wear is affected by working conditions.



3. The daily changes in structure of the metal, "chill," and amount of metal to be removed.

4. The method of grinding employed by the operator, whether the work is done with the edges of the wheel or the face, and the amount of traverse of the work with respect to the wheel.

5. The rigidity with which the work is held while being ground.

6. The condition of the grinding machine with especial reference to the bearings, tension and width of belts, and amount of power available.

Each of these factors may have more effect upon the grinding action than a change of grit or grade of the abrasive structure. This is why no one can reliably foretell the grit and grade of snagging wheel best suited for a particular set of operating conditions. Foundries of the same concern and making the same product will select grinding wheels of different structure.

Snagging Machines

The four general types of snagging machines now being used by American foundries are the floor stand, the swing frame, the planer type and the portable grinding machine. In spite of the variety, however, the principles governing the use of this equipment are essentially the same although differences of metal and shape cause the factors which require consideration to be arranged in different combinations. The construction and application of the machines greatly affect the amount of service rendered by the grinding wheel and many improvements are being made in the design of this equipment.

Vibration

Vibration is seriously detrimental to efficient grinding and must be guarded against. Vibration is tiring to the operator,

it requires the machine to withstand stresses and strains for which it was not designed, it increases the care of maintenance and reduces the grinding capacity and rate of cutting of the abrasive structure. It is objectionable from every standpoint and has not one redeeming feature to compensate for the loss which it causes.

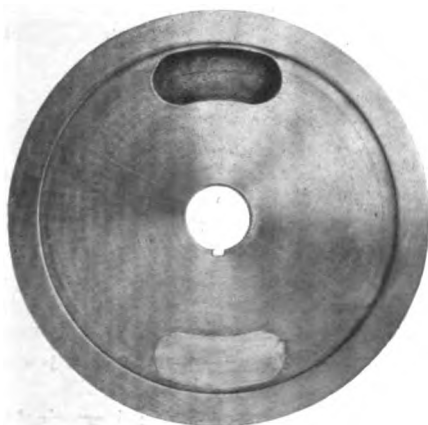
Vibration occurs with loose bearings, stiff joints of belts, insecurely holding the work and with an unbalanced condition of the rotating parts. The last factor is the most important as it causes the bearings to become loose and increases the difficulty of rigidly holding the work. The rotating parts consist of spindles, pulleys, flanges and the grinding wheel. The grinding wheel is the most responsible for balance because it is the largest and heaviest part of the rotating system. It is, however, the most difficult to have in balance because its life with respect to that of the machine is very short and the amount and location of the unbalanced section vary as the wheel wears away.

Balancing Snagging Wheels

Norton Company for many years has balanced snagging wheels according to the following method:

"Straight wheels are put in balance by inserting lead near the lead bushing. The amount of lead that has to be inserted for different amounts out of balance can be closely figured out and arranged in a table. We have such a table in use in our shop. To take up the lead, a part of the wheel adjoining the bushing opposite the heavy spot is chiselled out and lead is poured into the cavity thus formed. Any protruding lead is cut off and the wheel is placed back on to the balancing ways to see whether it is in standing balance. If not enough lead has been inserted more of the wheel has to be cut out and more lead poured in. In the other instance some of the lead has to be removed."

[SEPTEMBER, 1918]



Fixed Flange



Loose Flange

BALANCING FLANGES

The face of each flange is graduated in inch-ounces which is the radius of the grinding wheel multiplied by the ounces out of balance. The proper marks on the flanges are then set under the line painted on the face of the grinding wheel. Read below.

This practice, however, is not entirely satisfactory because its effect is not permanent and as the wheel becomes smaller it must be periodically removed from the spindle and have the balancing lead drilled out.

No lead is inserted if the wheel is only a trifle out of balance. Hence, the absence of lead is no indication that the wheel is in perfect balance.

The importance of maintaining good balance of the rotating parts of a snagging machine has become apparent. Balancing flanges have been designed to reduce vibration and are now being employed with good results. By their use the grinding wheel can be kept in continual balance by their occasional readjustment.

These flanges require no extra space on the spindle and serve as the regular flanges. Two slots are milled in each flange, one is filled with lead and the other is left hollow.

[SEPTEMBER, 1918]

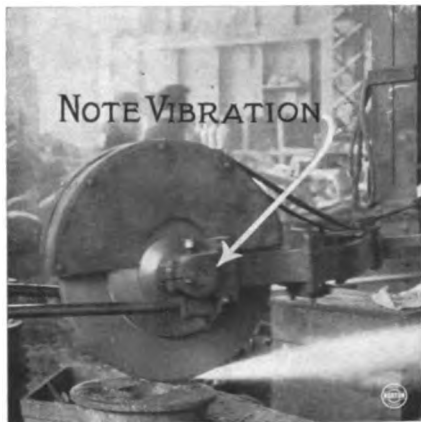
The flanges are in balance when the heavy spot of one covers the hollow spot of the other. The inside flange is keyed to the spindle, and the outside flange is graduated with marks which show what its position relative to the fixed flange should be for any given amount out of balance. Any ordinary pair of heavy steel flanges will serve for this purpose. Blue-prints, showing the dimensions of the slot and the position of the graduated marks, will be furnished on request, by the Norton Company.

When the location and the exact amount out of balance are known, it is easy to quickly adjust the flanges to the proper position. The Norton Company tests all snagging wheels and, if desired, those wheels which are out of balance may be marked on the face to indicate position of the balancing flanges as well as the amount out of balance. In this way, the wheel may be placed on the spindle and the proper graduation of the flanges set under

[5]

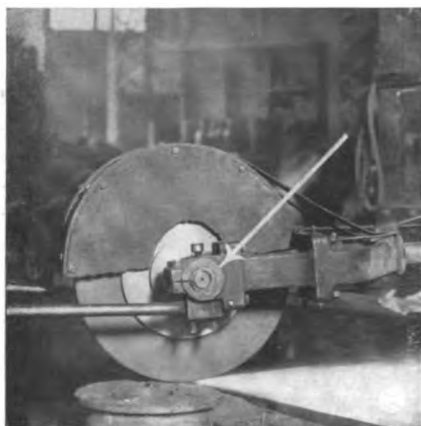


the mark which will be painted on the face of the grinding wheel.



An ordinary condition of operation. The rotating parts are not in balance.

When the wheel wears down and vibration again becomes evident then the machine may be stopped, the spindle nut



The rotating parts have been put in balance by the adjustment of the balancing flanges. Note the elimination of vibration.

loosened and the loose flange and the grinding wheel turned part way back to zero. The amount which it is turned depends largely upon the reduction in the diameter. In case the flange should be moved in the wrong direction it will be apparent as soon as the machine is started. The rigidity of the snagging machine will absorb a slight amount of out of balance so that the adjustment need not be very accurate. The main object of the balancing flanges is to correct for the variation in density of the snagging wheel, but it will also compensate for any out of balance of the pulley and other parts which rotate on the spindle.

Male labor is becoming increasingly difficult to obtain. It is not the strength required to hold the casting against the grinding wheel so much as it is the continual pounding and jarring of the machine which have delayed the use of women as grinding operators. Experience has indicated that a decrease in the footpounds of work to which one is subjected is usually accompanied by an increase in dexterity and quality of intelligence. If this does not occur with the same operators, the work will at least attract a better class.

The two photographs of the swing frame machines show the advantage of using balancing flanges. The elimination of vibration in the snagging machines of foundries will do more good to conserve labor and materials than could be effected by the alteration of any other one factor of snagging.

Heavier equipment assists to reduce vibration, but the rigidity is quickly decreased unless the rotating system is in balance. For these reasons as well as the fact that increased service may be obtained from abrasive material when it is rotating without vibration, it is believed that the use of an auxiliary balancing device, such as balancing flanges, is the next step in the advancement of the snagging of metal.

Norton Grinding Wheel Stands

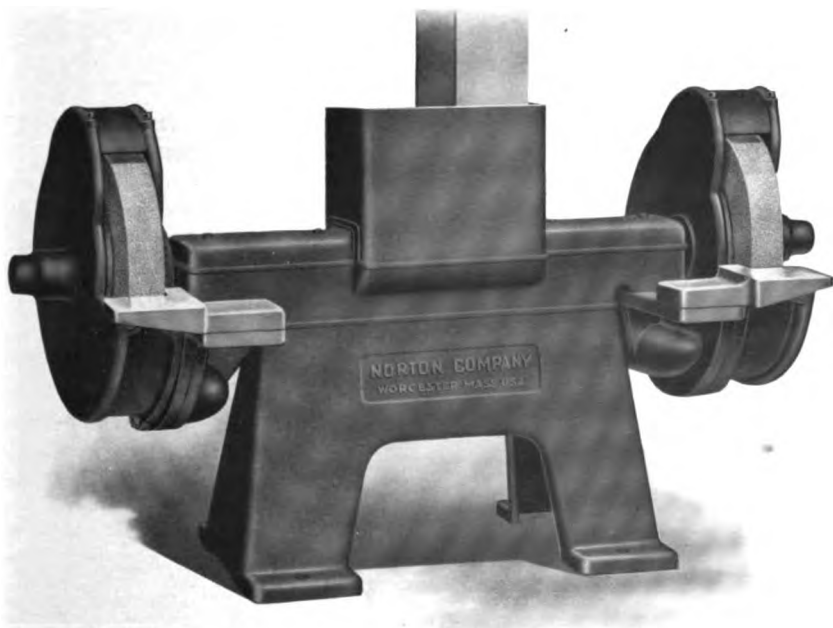
BY W. T. MONTAGUE

These machines are made in both bench and floor types and each type is made in two models, Model D (as shown below) and Model C, a somewhat lighter and less expensive machine.

The newer design, Mode D machine, has many superior teatures not to be found in most machines of this kind on the market. First, there is the desirable quality of rigidity due to the great weight of metal employed in the base casting. Ri-

gidity means less wear and tear on the machine and more economical use of grinding wheels—both factors of extreme importance nowadays.

The second point that catches the eye as you look at this machine is the length and dust proof qualities of its spindle bearings. The weight and rigidity of the Model D floor stand permit of sufficient overhang of the bearing bed to allow plenty of foot-room for the operators.



Norton Floor Stand—Model D



Norton Bench Stand—Model D

This enables a man to stand up close to the wheel without bending over as much as is usually necessary while grinding.

There is a good heavy work-rest broad enough to actually take the weight of the casting off the operator's arm and the vibration from his wrists. The top surface of the work-rest is chilled, thus insuring long life. However, should it be necessary to remove the rest in order to grind in certain instances, this can be speedily accomplished.

The belt guard and protection hoods cover the moving parts sufficiently to reduce the possibility of accident to a minimum. The hoods have an adjustable tongue which can be reset quickly as the grinding wheel wears down, thus keeping the opening for the wheel about constant and insuring approximately the same protection throughout the life of the wheel.

[8]

Another important feature that is incorporated in the protection hood is the exhaust pipe connection that permits the carrying away of the chips, dust and smoke of grinding. The exhaust connection is required by law in many states.

The hood also covers the revolving nut on the wheel spindle which has always been a menace to workmen.

Both Models C and D floor stands are made with $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", $1\frac{3}{4}$ " and 2" diameter spindles and an attempt is made to carry these sizes in stock. Although not carried in stock, a $2\frac{1}{2}$ " floor stand can be supplied on order.

The Model D bench type stands are patterned after the large floor machines and have all of their desirable features. This can be seen from the cut below.

The spindle sizes for the bench machines are $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ ", 1" and $1\frac{1}{4}$ ".

[SEPTEMBER, 1918]



Both bench and floor stands have two sizes of spindle pulleys so that the speed of the grinding wheel can be properly increased as the wheel wears down. By this means there is an opportunity to get greater work from a wheel than would be possible if the surface speed was allowed to gradually drop until the wheel was worn out. Special countershafts with two sizes of driving pulleys can be ordered sep-

arately, if they are required, as these too are usually carried in stock.

If these grinding machines are placed on a solid foundation, they will perform the heaviest of work day in and day out with a minimum of time lost in repairs. They are especially desirable as they safeguard the operator in every way, as well as reduce the cost of grinding castings.

A catalogue and further particulars can be secured on request.

Little Known Facts About Grinding

Cam Grinding—What Causes Cams to Show Softness After Grinding

BY HOWARD W. DUNBAR

A frequent difficulty met with in cam grinding is a sequel to the effect produced in the use of too hard a wheel, which causes the face of the cam to crack or check. This difficulty is known to the operator as the softening of the cam and is usually charged by him to some defect or error in the machine attachment or method, whereas as a matter of fact in almost every case it is due to carelessness in regulating the work speeds, the depth of cut or the grade of the wheel used.

By the best known methods of testing hardness, either by the Brinell meter or the scleroscope, when the proper speeds and grades of wheels have been used there is no effect of softening that can be detected by such tests. This matter comes back to the same old difficulties in cam grinding, namely, that it is usually the common practice in finishing cams to use

too hard a wheel, which in order to act properly causes the operator to take too deep a cut, which generates so much heat that the compound does not dissipate it fast enough and the temper in the cam is drawn slightly, or in the other case when the other defect is noticed the cheeks of the cams are checked or cracked. But when light cuts are taken and soft wheels used these errors are entirely removed.

There is a knack in grinding cams which requires greater skill on the part of the operator than in most grinding operations. It is largely due to the fact that the cam is of an irregular shape and the action of the wheel at different points on the periphery of the cam varies, so that the operator has to use a great deal of care in adjusting other conditions, such as the speed of work, depth of cut, flow of water, etc., to bring about the desired results.



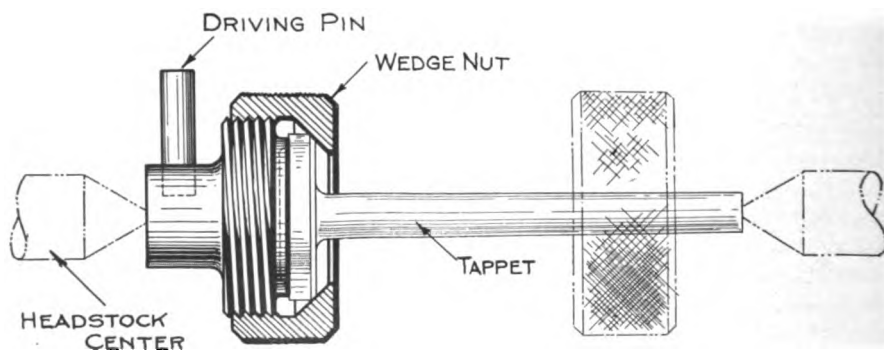
Grinding Kinks

Quick Acting Holder for Valve Tappet Grinding

By HOWARD W. DUNBAR

The illustration of the holder requires little explanation. The nut which is knurled on the outside is large enough to be operated by hand. The angle on the front end opposite the threads engaging the chamfer on the under side of the head of the tappet draws the head of the tappet central and up against the locating surface of the threaded portion of the holder, thus bringing it in line with the center near the driving pin and on the axes of rotation

of center in the small end of the tappet. The threads in this holder should be relatively coarse so that the action will be quick. By merely loosening the nut and removing it from the head or driving end of the holder the tappet can easily be removed and another one inserted. It is important that the face of the holder where the head of the tappet is drawn up should be relieved so that there will be a ring bearing near the outer edge.



In order to teach or prescribe rules one must be able to operate the grinding machine and produce a commercial quantity of really good work



Reflections of the Foundry Man who made a Journey to the Home of the Grinding Wheel

The foundry man who had the good fortune to go into the home and birthplace of the grinding wheel had his eyes opened to the amazing amount of progress which has been made through the closest kind of study and experimentation in adapting the grinding wheel to the needs and demands of all kinds of industries, especially those of the foundry.

This foundry man recently had the important work of planning and developing a gray iron foundry of fifty tons of cleaned castings per day capacity—work which followed an extensive experience in the management of a general manufacturing business of considerable proportions, where iron and steel castings were consumed in large quantities. Consequently, his experience in the months he spent in the home of the Norton grinding wheel had a great significance for him. Nor was it without regrets for the lost opportunities when as business manager or foundry man he had allowed others of the operating staff to deal with the representatives of the grinding wheel manufacturer instead of seizing the opportunity himself.

These grinding wheel representatives are graduates from a school where very special study has been given to the problems that daily vex the soul of the foundry man, and they stand ready, being genuinely interested both in his troubles and his successes, to go the limit in helping him out.

The foundry man who met them, studied with them, saw the organization and resources back of them, cannot be too emphatic in urging others to take advantage of all that the Norton Company has to offer in the way of helpful service.

Open the door wide and invite the grinding wheel man in to tell you, the pro-

ducer, how you can help yourself to better results in your casting-snagging department.

Make use of the research work and practical experience of the grinding wheel manufacturer. Welcome his representative. If he doesn't come in, send for him and get from his fund of information many things which you can't get out of books. There is more information, such as you need, under his hat than there is between the covers of his catalogue, splendid as it is. You may ask just how the grinding wheel man can help. Let us be specific.

When our foundry man who had the chance to receive "more light" was planning the arrangement of his cleaning and grinding room, he had a very pretty engineering problem to work out—floor space occupied with the particular kind of castings to be snagged, foundations, number and kind of floor stands, swing frame and pneumatic grinders to be selected and installed, transmission to drive all these, factory laws to be considered which dealt with protection hoods, dust exhaust systems and many other similar and contingent details.

Able engineers considered these matters, but not a man among them could plan for the best results from the standpoint of the grinding wheel, since not one among them was familiar with the grinding wheel, its construction and its needs.

Had there been an engineering voice for the wheel, with ultimate production in mind, based upon abrasive efficiency, properly sized machine spindles, wheel speeds, suitable machine foundations, safety flanges, protection hoods, transmission and dust exhaust systems, above all, a careful selection of wheels for the work to be snagged, we should have had a



much more desirable cleaning and grinding department and a handsome return in savings, as a result of the difference between doing things fairly well and doing them after the best approved methods.

The foundry man who made the "little journey into the home of the grinding wheel" has had a vision of manufacturing processes, painstaking selective grading

methods, following the most exhaustive studies of the qualities and application of abrasive materials to the production of grinding wheels for use in industry at large and in very particular measure for use in the foundry snagging department, which brings him to a realization of the great value of the efficient trained service of the Norton Company.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Improved Small Grinder. American Machinist, European edition, August 3, 1918, page 139E. Description of a grinding machine made by Morton & Weaver, Coventry.

Grinding a Countersink in Chilled Castings. American Machinist, August 29, 1918, page 400. This operation is performed very successfully by the use of round sticks of Crystolon. This article describes also the grinding device rigged up for this purpose.

Fixture for Grinding. American Machinist, August 29, 1918, page 410C. This fixture has been designed for use on a disk grinding machine.

Make Plant Ready to "Toe the Mark." Brick and Clay Record, August 27, 1918, page 375. "The dryer, kilns and systems of material distribution are phases of the plant which by a few alterations can be put on a better operating plane for the big spurt after the war."

An Effective Home-made Track Grinder. Electric Railway Journal, August 31, 1918, page 380. Description of a track grinder made from old material in the shops of the Charlottesville & Albemarle Railway.

Robbins, Gamwell Circular Cutter-grinding Machine. American Machinist, August 15, 1918, page 318. This machine, designed particularly for grinding convex and concave profile cutters, is marketed by Robbins, Gamwell & Co., Pittsfield, Mass.

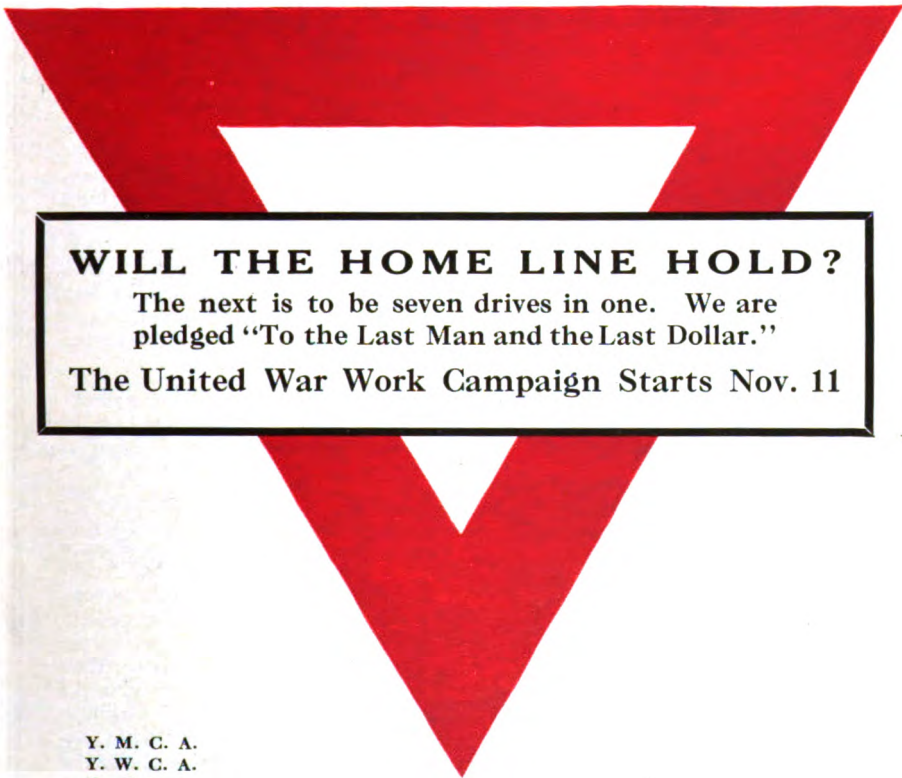
The Pros and Cons of Clayworking Screens. Brick and Clay Record, August 13, 1918, page 295. This article discusses the good and bad points of various types of screens used in clayworking.

Effect of Imperfect Centres on Cylindrical Ground Work. American Machinist, August 22, 1918, page 357. In this article Mr. Robert J. Spence describes several difficulties met in cylindrical grinding which are due to the poor conditions of the centre points of the machine and the centre holes of the work. He also tells how these difficulties may be overcome.

Operating a Pit Grinder Without Rheostatic Losses. Electric Railway Journal, August 17, 1918, page 277. The method used by the San Diego Electric Railway is described briefly.

GRITS and GRINDS

October  1918



WILL THE HOME LINE HOLD?

The next is to be seven drives in one. We are pledged "To the Last Man and the Last Dollar."

The United War Work Campaign Starts Nov. 11

Y. M. C. A.

Y. W. C. A.

K. of C.

Jewish Welfare Board

War Camp Community Service

American Library Association

Salvation Army



Grits and Grinds

Vol. X

October, 1918

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Making Better Soldiers

Lieutenant-Colonel E. S. Wheeler, in a letter to General Pershing, said:

"There is no one factor contributing more to the morale of the American army in France than the Y. M. C. A. The value of this organization cannot be overestimated. When I come to the Y. M. C. A. huts and see our men night after night and one day after another in their spare moments enjoying the privileges created by a corps of self-sacrificing Red Triangle workers, I know that they are better men and better fighters for so doing. *Give me nine hundred men who have a Y. M. C. A. rather than one thousand who have none, and I will have better fighters every time.*"

In November there is to be a United War Work Campaign to collect \$170,500,000. There are seven great agencies that will benefit through the event: The Y. M. C. A., Y. W. C. A., K. of C., Jewish Welfare Board, War Camp Community Service, American Library Association and the Salvation Army. Each of these agencies has its own work to do. They are not private agencies. Every one is operated under the executive order of President Wilson; the budget of every one is scrutinized and passed by the War Department.

The field army of these seven great agencies comprises more than fifteen

thousand uniformed workers on both sides of the water, and General Pershing is asking that additional workers be sent at the rate of at least a thousand a month. We all know of the great work they are doing. In camps and cantonments on this side, and on the other, there are 842 libraries and 1,547 branches. There are 250 additional libraries on the ships of our fighting fleets and merchant marine. These organizations furnish the boys with 125,000,000 sheets of stationery a month, and probably half a million dollars is kept tied up all the time in postage stamps. Under the direction of these agencies more than 500 tons of supplies for American soldiers leave our ports every week.

It is estimated that the cost of keeping the American soldiers in arms next year will approximate \$24,000,000,000. It is surely worth \$170,500,000 to make them fight 10 per cent. more efficiently.

Every letter that comes from France on a Y. M. C. A. or a K. of C. letter-head is an endorsement of the good work these organizations are doing. Every day we read in these letters the strongest kind of testimonials of their good work. Whatever you give the United War Work Campaign will be used to make better and more efficient soldiers and to bring the end of the war nearer.



Use Wheels of Large Diameter for Snagging Castings

[Extracts from the Sales Engineer's Correspondence Files]

Salesman's Communication

"One of our customers has raised the question of whether the diameter of a wheel will have any bearing on the cost of grinding, especially so on heavy work like steel castings. This customer in question uses 18" diameter wheels on swing frames. Kindly advise me if you have any actual data on this."

The Reply

We have no actual figures to show what the effect of wheel diameter is on the cost of snagging castings, but perhaps a brief, general discussion is in order.

To take an extreme case, we would hardly use a 4" diameter wheel to snag castings, for the principal reason that you could not remove metal fast enough. Under usual power conditions for a 4" wheel it would slow down and stop just as soon as any considerable pressure was put upon it. Now, an 18" diameter wheel, driven with proportionately larger belts and greater motor power, would have sufficient momentum to keep going, even under great pressure. There is no question but what theoretically there is something to be gained from this flywheel effect which keeps the speed up and hence tends to reduce the wheel wear.

Another point is worth considering, and that is the arc of contact. The larger the diameter of the grinding wheel, the more

cutting grains are at work each second, due to increased arc of contact. This makes for two things, faster cutting and less wheel wear.

Still a third factor is the greater economy in abrasive consumption that always exists when the grinding wheel is large and up to speed. Say that a steel foundryman is snagging drawbars with an 18" diameter wheel. Each drawbar ground requires an average abrasive consumption of about 2 cu. in. Now, a wear of 2 cu. in. on an 18" diameter wheel represents a much less reduction in diameter than a wear of an equal amount on a 14" diameter wheel. The more a wheel reduces in diameter for each piece ground, the less its surface speed and the smaller the arc of contact. Unless the correct surface speed is maintained almost absolutely, both of the factors mentioned tend to make the grinding wheel wear out fast and hence lower its efficiency.

Now, these considerations are somewhat theoretical but sound. They point to the use of as large a diameter grinding wheel as can be employed, taking the type of machine and the strength of the operator into consideration. We should advise the use of at least 18" diameter wheels on the swing frame grinding machines, and larger if within the limits that the machine operators can stand.

Our customers buy wheels for this purpose ranging from 16" to 24" diameter, the majority being 18" and 20" diameter.

A snagging wheel of the correct grain and grade will cut faster if not forced too hard. Contrary to many opinions it is not necessary to force a wheel hard to make it cut if the grain and grade are correct



Microscopic Examination of Grinding Chips

By R. M. JOHNSON

The photographs accompanying this article are, we believe, excellent examples of the results to be expected when the grain and grade of a grinding wheel are changed.

All of the chips were collected during the roughing operation of crankshaft pins from the black stock. On this particular operation, steel is removed at the rate of $2\frac{1}{2}$ cubic inches a minute on the Norton Double Head Crankshaft Grinding Machine. These pins are rough ground to 1.405" diameter.

Figure No. 1 shows the chips produced by a fast, free-cutting wheel. Figure No. 2 shows those from a harder, finer wheel

and figure No. 3 from a wheel which was very inefficient in hourly and total production. All of the chips are magnified 20 diameters.

It will be noticed that the chips shown in No. 1 are of good size; the presence of particles of abrasive indicates that the wheels are soft enough to allow the face to break down and maintain its "edge."

From figure No. 2, one can see that the finer, harder wheel produces smaller chips, but instead of removing clean, well-formed chips, some of the material is actually melted off. This is shown by the presence of small globules of metal. There are practically no abrasive grains present, but



Figure 1

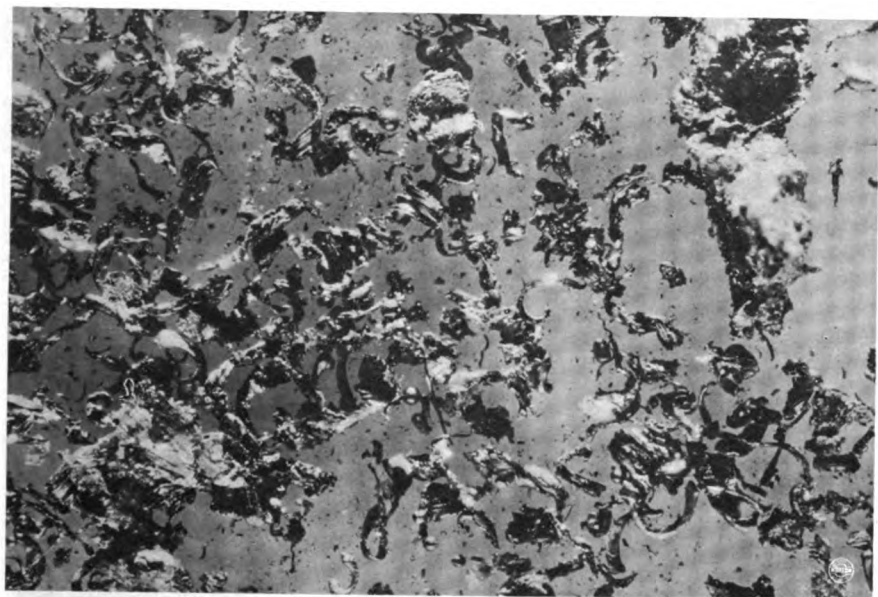


Figure 2

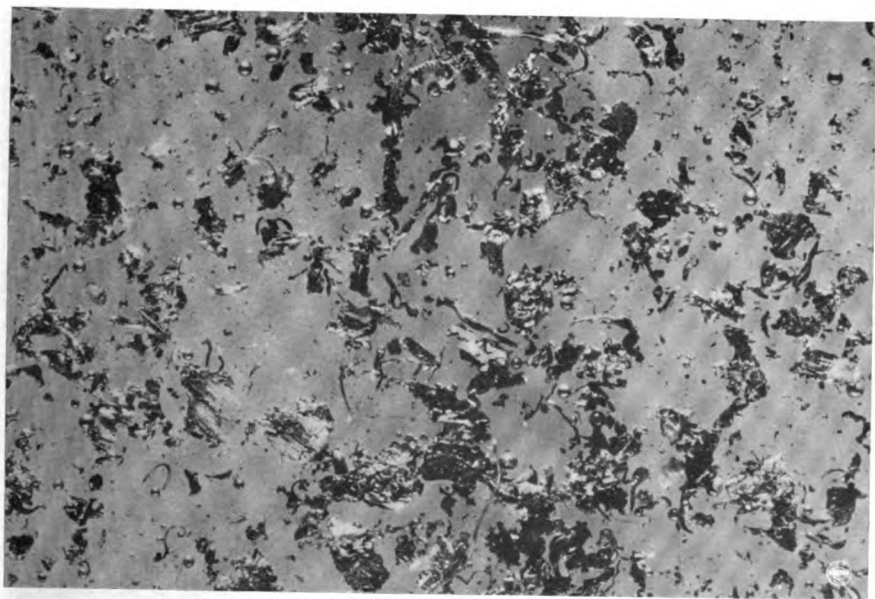


Figure 3

[OCTOBER, 1918]

[5]



in spite of this the wheel actually produced only sixty per cent. as many pieces as the first wheel, the greater wear coming from the more frequent dressings necessary to keep the face sharp.

Wheel No. 3 removes chips smaller than the other two and produces a great deal more heat, shown, of course, by the large number of metallic globules present. Its

hardness is indicated by the absence of abrasive grains.

We believe that a great deal of valuable information can be obtained by a microscopic examination of this kind. The Norton Company will be pleased to examine chips sent to them, and their representatives will be glad to be of assistance at any time along these lines.

The Value of Protection Hoods

By ALPHONSE ROUSSEAU

Many users of wheels do not realize the importance of the proper construction of protection hoods. In order to perform its function of "protection," a hood must be more than merely an enclosure for the wheel. It must be an enclosure which is strong enough to retain the pieces of a wheel which might break while in operation and do it repeatedly. A piece of tin or sheet iron bent into shape and painted green may *look* like a good hood, and an operator will work in front of it with a feeling of perfect safety. He *will be* safe as long as the wheel does *not* break; but if through some accident the wheel *should* break—we leave the result to your imagination.

Yet there are many such hoods in actual use. They were probably designed to carry away the dust, and possibly this is done satisfactorily. The real test of a hood, however, does not come until a wheel is broken in it. It should be remembered that a good dust hood is not always a protection hood. A well-designed protection hood, however, can be made to serve as a dust hood also.

The accompanying illustrations show what happens when a wheel breaks in a

hood that is not strong enough. You will note that the hood here shown was con-



Picture taken immediately after breakage
siderably heavier and stronger than many so-called protection hoods in actual use.

[OCTOBER, 1918]



It is not difficult to imagine what might have happened to an operator standing in front of this wheel when it broke. (Note the pieces of broken wheel and bolts at the bottom.) Even with the wooden barricade shown, which was designed to stop any pieces which might escape from the hood, one piece did fly 27 feet from the machine. This is shown at the bottom of the picture with the figure 27 in chalk.

The test pictured here is one of a series being conducted by the Safety Committees of the Grinding Wheel Manufacturers of the United States and Canada, and the National Machine Tool Builders Association, to determine the size and spacing of bolts and rivets in fabricated hoods.

The wheel here shown was broken at approximately 9,000 surface feet per minute. Although this is higher than a normal working speed, it is not uncommon to find wheels actually running at this speed. Hoods, therefore, must be made strong enough to hold wheels which might break at that speed.



Same hood as shown in other illustration, but with cover removed to show broken wheel

Grinding Drills by Hand

In a very complete article on drill grinding in a recent issue of "Machinery" Edward K. Hammond describes the following method of grinding drills by hand. We do not wish to create the impression that Mr. Hammond is recommending hand grinding of drills; in fact at the beginning of the article this statement appears:

"For the average shop, the only way to be sure of attaining the desired results is to have the drills ground on special drill grinding machines which are so designed that they assure producing drill points that meet all requirements."

How to Grind a Drill by Hand

It is a difficult matter to grind a drill by hand and secure the desired results

without taking altogether too much time in performing the grinding operation. Nevertheless, the mechanic who makes an intelligent study of the requirements of drill grinding can learn to grind a drill by hand after he has had enough experience to enable him to acquire the necessary degree of dexterity. One method of grinding drills by hand, which is capable of giving satisfactory results, is to hold first one lip of the drill and then the other against the grinding wheel so that a flat clearance surface is ground at the back of each cutting edge. In doing this work great care should be taken not to change the angle which the chisel point of the drill makes with the cutting edges, as it is the angle of the chisel point which determines the amount of clearance provided for the



cutting edges. After these flat clearance surfaces have been ground, the mechanic very carefully swings the drill back and forth so that the flat ground surfaces are blended into the remainder of the surface back of each cutting edge. This method of grinding will not produce a drill point which appears to approximate closely the form produced on a drill grinding machine, but the results obtained with a drill ground in this way will often be far more satisfactory than those resulting from the use of a drill ground by hand, where the mechanic has attempted to secure a closer approximation of the original form of the drill point through swinging the drill back and forth on the surface of the grinding wheel.

If the mechanic attempts to grind a drill by hand and duplicate the movement secured through the use of a drill grinding machine, the proper method of procedure is as follows: The drill is held between the thumb and index finger of the left hand at a short distance back of the point, and the hand is steadied by the tool-rest of the tool grinder. The drill is held at such an angle to the grinding wheel that the sur-

face of the drill point rests flat against the wheel, and great care must be taken to have the chisel point of the drill in a vertical position; in other words, the cutting edge of the drill is inclined upward. With the drill held in this position, the mechanic grips the shank between the thumb and index finger of his right hand and slowly oscillates the drill about an imaginary axis, between the thumb and index finger of his left hand, taking care to keep the chisel point vertical at all times. After grinding one side of the drill in this way, the drill is turned over so that the other side may be ground. This method can be used with extremely satisfactory results by men who have had a great deal of experience in drill grinding, but it is probable that the average mechanic will secure better results through the method of hand grinding referred to in the preceding paragraph. In any case, hand grinding is not recommended for the average shop, as the superior speed and quality of workmanship obtained through the use of drills ground on a drill grinding machine are quite sufficient to warrant the investment in an equipment of this kind.

The dividing line between a finely ground surface and a polished surface varies according to the mind and eye of the critic. A perfect surface to one is a very imperfect surface to another



Little Known Facts About Grinding

BY HOWARD W. DUNBAR

Production

There have been a great many suggestions by certain people that it should be possible to reduce grinding problems, as they relate to production, to a scientific basis and establish a formula whereby given results could be predicted. So far as the present light in grinding leads us, this suggestion is an impractical one, for the reason that a formula to be correct would have to be developed for each individual operation. A formula which is determined for certain conditions is not correct over a range of work, due to the many variables that enter into production as related to grinding.

Take, for example, a piece of work which is $1\frac{1}{2}$ " in diameter and 36" long, of ordinary steel, say 40 Pt. Carbon, using a wheel of a given diameter, grain and grade and given dimensions. It requires a certain length of time to produce such a piece. Now we will suppose that this piece has all of the specifications above named, except in length. Assume this length to be 18" instead of 36". One would say off-hand that the work should be ground in one-half the time. This is not necessarily true, because of certain conditions that enter into the grinding. Among others is the time consumed in the reversal of the table at each end of the stroke, relative to the time the wheel is actually in contact with the piece of work 18" long and the piece of work 36" long.

This illustration is merely drawn to emphasize how small a point can influence the quantity of production in grinding work.

Aside from these fixed factors which are governed by certain known laws there is

the personal factor which varies with each individual operator, his attitude towards his work and the skill with which he is able to accomplish his work, the surrounding conditions in the factory for convenience of operation of the machine, light, ventilation, method of pay—whether by piece work or day work—etc. We have so many examples of this personal factor playing such a part in the amount of production that it eliminates fixed formulas beyond the question of a doubt.

Then the points which are within our control are so numerous and vary with almost each different piece to be handled in the grinding machine. For example:

1. Whether the part is hardened or soft steel.
2. What is the carbon content?
3. Is it an alloy steel?
4. The limits to which a piece is to be ground. (In some instances .00025" or .0005" increase in the limit may double the production.)
5. The cross section of the piece being ground relative to its length. (In the case of tubing, for example, the production is slowed up enormously due to a tendency to warp or change the axis of rotation caused by heat, which can usually be traced to too hard a wheel.)
6. The diameter of the piece being ground.
7. The length of the piece being ground.
8. The number and position of steady-rests employed.
9. The toughness of the material being ground.



10. The tensile strength of the material being ground.

11. The kind of finish required

12. The quality of the wheel being used, both grain and grade.

13. The design and make of machine

upon which the work is being ground, with particular reference to rigidity.

One could go on subdividing these points indefinitely, but the final conclusion would be that formulas break down under so many variables.

The Superiority of Alundum for Polishing

Polishing room tests with abrasives very often bring out some interesting data. It would be unusual if, in any polishing test with abrasives, Alundum did not demonstrate its fast-cutting qualities. Sometimes the percentage of increased production is not large; but when the factors of glue, labor and quantity of abrasive used are considered along with the increased production, it is merely a question of a little figuring to show that the saving is worth while.

A very interesting test was recently conducted on exceedingly rough steel forgings. Two kinds of work were used in the test. One a steel forging about 36" long, 2" wide and $\frac{3}{8}$ " thick, very rough, containing lumps and fins from forging; the other was a piece weighing about 50

lbs. round tapering from about 9" or 10" to 8" or 9", nearly a cylinder, also containing small lumps which tore the abrasive off the rag wheel in large chunks. The number of the abrasive in each case was 30; the kind of wheel and the glue were the same. All conditions were equal.

With the first named piece an Alundum wheel finished five and a competitive wheel four. With the other piece an Alundum wheel finished eight and the competitive wheel six. The time reported shows that seven pieces were finished with the Alundum wheel in seven-eighths of the time required with the competitive wheel.

The results showed not only an increase in production but a saving in glue, quantity of abrasive used and most important of all—a saving in labor.

In the snagging of castings, soft, stringy materials generally call for comparatively coarse grains and medium hard grades. Dense, brittle materials require slightly finer grains and harder grades



Grinding Kinks

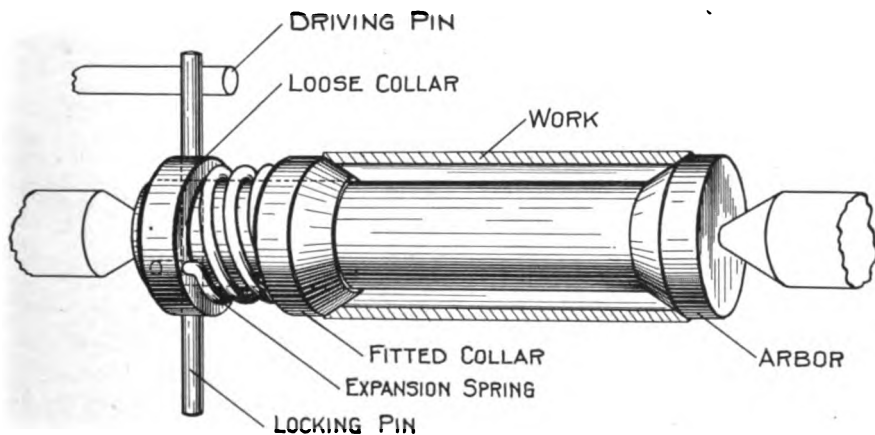
By HOWARD W. DUNBAR

Arbor for Grinding Piston Pins

The illustration below is a convenient arbor for grinding piston pins where the wall of the pin is thin and apt to be sprung if screwed up too tightly with the usual arbor employed in grinding piston pins. In this case the locating member on one end is actuated by a coiled spring which brings an even tension on the end of the piston pin every time. These arbors are in use in the various factories and where used are reported to have produced excellent

results where very close limits are required.

The spring is less apt to be lost and cause trouble to the operator if fastened to one member or the other which it bears upon. The ring at the end of the arbor is there merely to serve as a backing for the spring, and is held in position by the locking pin which is slipped in through a hole which lines up with a similar hole in the arbor proper.



**The cylindrical grinding machine is what
its name implies---a grinding machine,
not a polishing machine**



Sharpen Against the Edge

One rule that has very wide application in using cutting tools is to sharpen against the edge.

With two exceptions all kinds of sharpening (both on grinders and oilstones) are performed with the edge of the tool working against the stone. The exceptions are (1) when sharpening on leather, as with a razor strop; (2) when the tool itself is held still while the whetstone or oilstone is moved to do the sharpening—as in sharpening a scythe or sickle with a whetstone or in sharpening the inside of a gouge or other concave edge with an oil-

stone slip. The reason for sharpening against the edge is that this results in less "wire edge."

Many people lay a blade on an oilstone and proceed to sharpen it by a circular or rotary movement. With a pocket knife or other short blade, this will put on an edge in time. But straight strokes sharpen more quickly. Moreover, in the case of chisel-like tools this rotary motion constantly changes the angle at which the tool is held and prevents the edge from being true.—From "How to Sharpen"—by Pike Mfg. Co.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Issues

Gagemaking in a Shell Plant. Machinery, September, 1918, page 1. Illustrated. The methods of grinding hardened gages at this plant are described in a paragraph of this article.

Grinding Relief of Milling Cutters. Machinery, September, 1918, page 10. Illustrated. A comparison of the use of disk wheels and cup wheels for grinding milling cutters, and an analysis of results obtained.

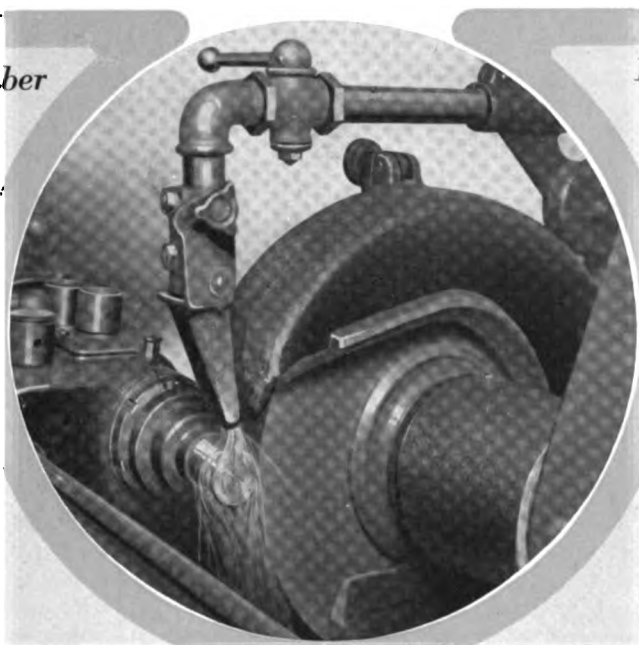
Ball Bearings for Machine Shop Equipment. Machinery, September, 1918, page 50. Illustrated. This article illustrates and describes the ways in which

ball bearings are applied in various types of machine tools and shop equipments. It begins with the use of ball bearings on grinding machines.

How to Handle Your Work on a Heald Magnetic Chuck. Heald Herald, September, 1918, page 24. Illustrated. This article explains the principles of a magnetic chuck, and of the Heald magnetic chuck in particular.

Elements of Gagemaking. American Machinist, September 19, 1918, page 511. Illustrated. In this paper the author deals with the distortion caused by grinding wheels.

GRITS and GRINDS

*November**1918*

THIS operation is the grinding of a piston for a tire pump held on a quick-acting expanding collet revolved in a live spindle attachment. The wheel width exceeds the length of the piston and traverse of the work is not required. A perfect fit with a corresponding cylinder must be obtained and the limits are plus or minus .001 inch. Twelve to fifteen thousandths are removed in the operation, yet the productive output nets 115 pieces per day per machine. It is a striking example of the adaptability of grinding machines of this type.



Grits and Grinds

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No. 6

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The Grinding of Commutators

A bulletin issued by the National Carbon Company, Inc., Cleveland, Ohio, contains the following information about the grinding of commutators:

Although sandpapering offers a satisfactory method of resurfacing a commutator which is dirty or on which the mica is just beginning to get high and although hand stoning will remove considerable high mica and even small flat spots, the only satisfactory methods of resurfacing a commutator which is badly out of true or on which the high mica or flat spots are bad enough to cause vibration of a hand stone, are grinding or turning with tools having a rigid support. All cases of eccentricity come under the latter head, for no hand method of finishing can eliminate eccentricity in a commutator.

Before undertaking to grind or turn a commutator examine it carefully and make sure that it is tight. This should be done just after stopping the machine, while it is still hot, as the bars are most likely to be loose at such a time. Due to the seasoning of the insulation, most commutators need to be tightened after six to nine months' service and again after eighteen months to two years. Thereafter they should remain tight indefinitely.

Before starting to turn or grind a commutator the windings of the armature, adjacent to the commutator, should be wrapped in canvas or oilcloth to protect

them from copper chips and dust. When the armature is to be ground at normal speed in its own bearings it may not be feasible to do this, but the armature should be so protected whenever possible and always when it is to be turned; otherwise, chips of considerable size are practically certain to lodge in the windings, and "shorts" are likely to result.

In grinding, there are two general methods: one a stationary stone, the other a revolving wheel of abrasive material.

When grinding with a stationary stone a smooth, fine-grain sandstone should be used, the same as is used for hand stoning. This must be rigidly clamped in a holder and provided with a substantial support so there may be no chance of the stone digging into the commutator. Some experimenting may be necessary to determine the best cutting speed. Beyond a certain speed a stationary stone will not cut smoothly, and it is seldom possible to grind a commutator at full speed by this method. The best cutting speed will probably be found around 1,000 to 1,500 f. p. m.

The rotating abrasive wheel is preferable to the stationary stone, as it is not liable to chatter or dig into the commutator. A medium soft wheel should be used, as the face will not fill up with copper as readily as that of a hard wheel. Use a light cut to prevent wear of the wheel

giving the commutator a conical form. A heavy cut will also tend to reproduce any eccentricity of the commutator due to unavoidable spring in the supporting rigging. Where a commutator is badly out of true, it may be necessary to take a large number of light cuts; but this is the only way it can be brought back to proper shape. Machines for this purpose are available, designed for attaching in a substantial manner to the brush-holder rigging. Where a home-made device is prepared, this question of rigid support must be given careful consideration. If grinding is done with the armature in its own bearings, build up the support from the frame of the machine rather than attach it to the brush-holder rigging to secure a more substantial support. Speed the cutting wheel at the rate recommended by the manufacturer of wheel used. Commutator speed will be determined by conditions. If a commutator that is badly out of true is to be finished entirely by grinding, it will be well to remove most of the eccentricity with the commutator revolving at a moderate speed. This will avoid excessive wear of the grinding wheel. After the commutator is approximately true, it may be speeded up to its normal speed so that any distortion which takes place at such speeds will be eliminated.

Final surface may be obtained by the use of a very fine abrasive wheel or fine-grain sandpaper. Some manufacturers put the final surface on their commutators with a hand stone. Whatever method is used, care should be taken to eliminate all scratches, especially those in a diagonal direction on the commutator surface, and to bring the surface to as near a polished condition as is possible.

After a commutator has been finished it should be thoroughly cleaned, the armature carefully blown out to remove all copper chips and dust that may have lodged in the windings, the surface closely

inspected, and any copper that may have bridged across the mica removed. It should then be given a high potential test, 1,000 to 2,000 volts, to make sure that there are no grounds. These precautions will be found well worth the time they require, in the subsequent troubles thereby avoided.

Grinding and turning each have certain advantages as a method of truing a commutator. Probably, all things considered, better results will be obtained from grinding when properly done. Less copper will generally be removed from the commutator by this method. The face of each segment will have a true curvature. This condition, as has been pointed out, is not always attained in turning; the cutting tool may twist the segments enough that one edge is cut slightly deeper than the other. Grinding, unlike turning, can be done with the commutator running at full speed and any distortion due to this speed eliminated.

The Norton Company has developed a series of elastic bonded bricks (1 x 2 x 8" and similar sizes) which have given excellent satisfaction used in the tool post on a lathe. For rough stoning, 6680-2½ Alundum elastic is the brick used, followed by 66180-1½ Alundum elastic for finishing. Many times the commutators are not in very bad shape and a 66120-2 can be used for both roughing and finishing.

Where it is possible, however, we advocate using rotating grinding wheels for truing commutators in place of either bricks used in a lathe, hand stoning or steel tools. The chief reason for this is because of the greater accuracy that can be obtained by this method, combined with high finish and slight reduction in commutator diameter.

For rough grinding, 46 grade 2½ Crystolon elastic will usually give good results, followed by 80 grade 2 Crystolon elastic for finishing. Where a combination roughing and finishing wheel is all that is required, then a 60 grade 2 or grade 2½ Crystolon elastic may be used to good advantage.



Little Known Facts About Grinding

Grinding Lubricant—Its Use, Method of Mixing and Some of Its Diseases

By HOWARD W. DUNBAR

We are frequently called upon to discuss the question of grinding compounds and lubricants relative to the merits of the various makes of such materials offered on the market to users of grinding machines. As this question involves so many points, it seems fitting to suggest that almost any lubricant from clear water to clear oil is satisfactory on a grinding machine, with certain modifications. Clear water, of course, would cause trouble in the machine, because it would rust the parts. Therefore, there is a certain element introduced in grinding compounds as rust preventives.

The principal function of the compound or lubricant, however, is to carry away the heat from the grinding wheel, and the emulsion which is composed of a large percentage of water effectively performs this function. Certain grades of oil are introduced to serve as a lubricating medium between the cutting particles of the wheel and the work. Thus, we frequently call these compounds lubricants.

The emulsion must be of such a consistency that it will not readily float chips of steel or small particles of abrasive worn from the face of the wheel, because as these small particles are pumped around through the mixture onto the work they frequently cause scratches in the face of the work which are detrimental when highly reflecting surfaces are being ground.

Certain compounds when used repeatedly for a long time without renewing or refreshing become more or less stagnant; and when mixed with the steel chips, abrasive, and bond from the wheel, there is a certain chemical action that takes place and an odor is given off from the compound which is very disagreeable.

Where grinding departments have a large number of machines, it is always advisable to have a man look after the mixing of the compounds and the cleaning of the settling tanks. To accomplish this, extra removable settling tanks are sometimes employed, that they may be removed from the main tank and replaced with an empty or fresh settling tank, allowing the grinding operation to proceed. However, when the compound must be renewed the tank must be cleaned out by shoveling the settlement out of the bottom and thoroughly cleaning it, remixing the lubricant in accordance with the directions of the maker. That supplied by the Norton Grinding Company is a product of the White & Bagley Company, known as the Economy grinding compound, and is mixed 40 to 1. From this particular mixture is derived the name of the compound, as that is a very small amount of compound to a large quantity of water, whereas in most other lubricants the proportion of compound is very much greater to the same amount of water, in some instances even being as high as one pound of compound to a gallon of water.

Another difficulty with a great many compounds is the fact that they foam and rise up in the tank, overflowing the edges and causing untidy conditions around the machine base and floor. This is usually traced to the fact that there is an element in the mixture which causes the foaming, or the mixture has been mixed in too large a proportion of compound to water. In some lubricants, particularly the White & Bagley lubricant, if foaming is noticed at all, a slight sprinkling of kerosene in the foam, either from an ordinary squirt can or sprinkling in with the hand, overcomes this trouble.



The individual tank, or in other words a tank for each machine, is much the better way to handle the lubricating problem. Central pumping stations and large settling tanks give more or less trouble; and unless a great deal of time and attention is given to taking care of them, they have many more disadvantages than advantages.

The Norton Grinding Company fur-

nishes with their machines the White & Bagley Economy compound, which is the result of developments in connection with the work of the lubricating engineers of this concern and the Engineering Department of the Norton Grinding Company, because it possesses all the features requisite to a compound suitable for high-class grinding work.

The Trial Wheel Record Tag

By R. M. JOHNSON

By the use of trial wheels which are constantly sent out to the trade, either at the request of our representatives or of customers themselves, we endeavor to improve upon the results being obtained on the large number of operations for which grinding wheels are used. It is our desire that the best possible results shall be obtained with Norton wheels. To accomplish this, it is very important that the original orders contain a description of the operation and that complete reports on the action of the trial wheels be received from the customer. In some cases, we are able, from the data reported, to send a further trial which will be more satisfactory than the first.

To facilitate making this report, either to our representative or to the Norton Company at Worcester, we attach to each trial wheel a blue tag. This tag, which is $3\frac{1}{2} \times 10\frac{1}{2}$ ", consists of two parts. Before leaving the factory, both parts are properly filled out with the Norton number, customer's number, size, grain and grade, face, speed at which the wheel was tested, recommended speed, and the operation for which it was ordered. This identifies the wheel and the operation it is to be used on, and by detaching the lower part of the tag a permanent record of the wheel may be retained by the operator or foreman.

The complete tag should be allowed to remain attached to the wheel until it is mounted and should then be carefully preserved by the operator until the test is completed. The operator can then make his report by simply filling out the tag. This eliminates the very unsatisfactory verbal report which, by the time it reaches the shop superintendent or purchasing agent, is often very different from the original report made by the operator.

The two cuts show the proper method of reporting the action of a wheel that is more satisfactory and one that is less satisfactory than the wheel regularly used. These are illustrated by Figures 1 and 2 respectively.

Either "satisfactory" or "not satisfactory" should be checked. The figures giving the life, production, and total dressings should be inserted in the spaces provided. The description of the cutting action should be made by checking the words which best describe the action of the wheel. Care should be taken that two contradictory words are not checked. For instance, if the wheel is "too hard," it cannot be "too soft."

In the space provided for remarks, information showing how the trial compares with the standard can be given. In the

KEEP THIS TAG WITH
WHEEL UNTIL USED

GRINDING



WHEELS

Alundum**TRIAL WHEEL
RECORD TAG**Results may be noted on form below, mailed to us, or
handed to our salesman.

Norton No. 126793 Customer's No. 128

Size 24 x 1.515 x 12

Grain 46 Grade 0-0115 Face A

Tested at 1435 Rev.

Speed recommended - R.P.M. 875 to 1035

Speed within above range is dependent on condition of machine,
method of grinding and safety appliances used.For grinding crankshaft pins,
finishing after turning in
in lathe.

Satisfactory	Check Here	☒
Not Satisfactory	Check Here	☐

Life - In days Hours 69

Production - Total 3038 per Hour 44

Total Dressings 67 Pieces per Dress 453

Cutting Action Check Fast or Too Slow

Too Coarse or Fine	Too Hard or Too Soft	Loads - Glazes
☐	☐	☐

Remarks Ground 21.7% more pins per
wheel and 9% more per hour with
7% less dressing than standard.

Name, Grain and Grade of Competing Wheel:

Acme 24 grade 0

Remarks which averages 2496 pieces
in 67 hours with 57 dressings.

SEE OTHER SIDE

Tear off - IF SATISFACTORY - Retain
For reference in Reordering

Norton No. 126793 Customer's No. 128

Size 24 x 1.515 x 12

Grain 46 Grade 0-0115 Face A

Tested at 1435 Rev.

Speed recommended - R.P.M. 875 to 1035

Speed within above range is dependent on condition of machine,
method of grinding and safety appliances used.For grinding crankshaft pins,
finishing after turning
in lathe.

1022-6-10-04

KEEP THIS TAG WITH
WHEEL UNTIL USED

GRINDING



WHEELS

Alundum**TRIAL WHEEL
RECORD TAG**Results may be noted on form below, mailed to us, or
handed to our salesman.

Norton No. 126792 Customer's No. 128

Size 24 x 1.515 x 12

Grain 24 Comb Grade 0 Face A

Tested at 1435 Rev.

Speed recommended - R.P.M. 875 to 1035

Speed within above range is dependent on condition of machine,
method of grinding and safety appliances used.For grinding crankshaft pins,
finishing after turning
in lathe.

Satisfactory	Check Here	☒
Not Satisfactory	Check Here	☐

Life - In days Hours 55

Production - Total 1980 per Hour 36

Total Dressings 49 Pieces per Dress 402

Cutting Action Check Fast or Too Slow

Too Coarse or Fine	Too Hard or Too Soft	Loads - Glazes
☐	☒	☐

Remarks Ground 20% fewer pins per
wheel and 10% less per hour with
5% more dressing than standard.

Name, Grain and Grade of Competing Wheel:

Acme 24 grade 0

Remarks which averages 2196 pieces
in 49 hours with 57 dressings.

SEE OTHER SIDE

Tear off - IF SATISFACTORY - Retain
For reference in Reordering

Norton No. 126792 Customer's No. 128

Size 24 x 1.515 x 12

Grain 24 Comb Grade 0 Face A

Tested at 1435 Rev.

Speed recommended - R.P.M. 875 to 1035

Speed within above range is dependent on condition of machine,
method of grinding and safety appliances used.For grinding crankshaft pins,
finishing after turning
in lathe.

1022-6-10-04

case of the two wheels reported on the tags shown, we are interested in the number of pins ground per wheel, the production per hour and the amount of dressing necessary. The comparison between the trial and the standard, we believe, is best shown on a percentage basis.

As a matter of record, the name, grain and grade of the competing wheel may be inserted in the space provided, and under

remarks the record of this wheel can be given.

Tags filled out in this manner give a very complete history of the wheels and allow us to keep our records in such a way that the grinding information contained in them is very complete and in concise form. The detachable part of the tag should be retained by the customer as a permanent record from which to order additional wheels.

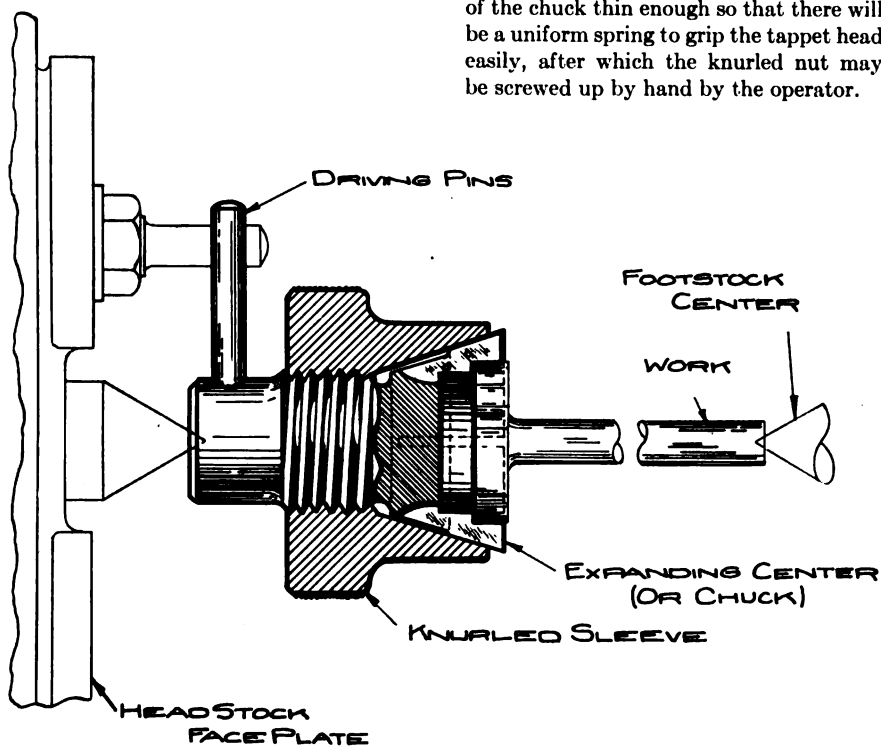
Grinding Kinks

BY HOWARD W. DUNBAR

The attachment we are illustrating this month is for work similar to other attachments which we have illustrated in past numbers. But in this case we are using the principle of the draw-in chuck or collet

applied to a little fixture for holding valve tappets where there is no center in the head end of the tappet.

The sketch is self-explanatory, and the only caution needed is to get the walls of the chuck thin enough so that there will be a uniform spring to grip the tappet head easily, after which the knurled nut may be screwed up by hand by the operator.





Patrick F. O'Rourke Succumbs to Pneumonia

It is with profound sorrow that we announce the death of Patrick F. O'Rourke,



for several years demonstrator of Alundum grain for polishing, whose activities extended through New York, New Jersey, and a part of Pennsylvania. His death occurred in St. Michael's Hospital, Newark, N. J., on Sunday evening, November 10.

Mr. O'Rourke's work brought him in close contact with many. He was giving strong evidence of his worth and ability when he was suddenly stricken with Spanish influenza, which quickly developed into pneumonia. He was about forty years of age.

The recent epidemic has caused the loss of a number of young men of promise in all fields of service, but it needs an individual case of this kind to bring home to us with full force the enormity of such a loss.

The body was taken to the former home at Ilion, N. Y., where the funeral services were held on the following Wednesday.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Issues

Blevney Type B-6 Motor-driven abrasive Finishing Machine. *American Machinist*, October 3, 1918, page 640. Illustrated. Marketed by the Blevney-Machine Co., Greenfield, Mass.

Wilmarth & Morman Mo. O Cutter, Reamer and Drill-grinding machine. *American Machinist*, October 3, 1918, page 640. Illustrated.

Making of Files Used To Be All Hand-work. *Canadian Machinery*, October 10, 1918, page 415. Illustrated. This article deals with the grinding process in the manufacturing of files.

Blevney Type A Tube and Rod Polishing Machine. *American Machinist*, October 24, 1918, page 778. Illustrated. A machine for polishing tubing, rods, or other cylindrical parts. Blevney Machine Co., Greenfield, Mass.

Reserve Source of Raw Materials for Artificial Abrasives. *American Machinist*, October 31, 1918, page 804. A general statement of the present condition of the supply of bauxite, emery, and corundum.

Diamond holder. *Machinery*, October, 1918, page 159. Illustrated. General description of a diamond holder which may be used on any grinding machine having a magnetic chuck.

Blair Thread Gage Machines. *Machinery*, October, 1918, page 165. Illustrated. This article describes various machines used in the tool-rooms of the Blair Tool & Machine Works, Inc., 515-521 Greenwich St., New York, N. Y. One of the machines illustrated is a thread gage grinding machine.

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GRITS and GRINDS

December ————— 1918

WE must continue to fight destruction and put in its place order, progress, and prosperity. These form the heritage of the world and, to give them to all, the willing co-operation of every one is necessary. The task of persistent thrift in money and resources is the task of the humblest and the greatest. It is steady, plodding work in the full light of the purpose of upbuilding, that is to lead to prosperity for all. This common endeavor brings the common reward of material happiness and spiritual brotherhood—and therein lies the truth for which we have been fighting, a real democracy.



Grits and Grinds

Vol. X

December, 1918

No. 7

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Final Conclusions From Grain Depth of Cut Experiments

By W. T. MONTAGUE

The following conclusions apply to what we term "roughing work" on soft steel, using a plain cylindrical grinding machine with traversing work table, revolving work, and a wheel-head that feeds into the work automatically.

Definition of Terms

By **WORK SPEED** is meant the peripheral or surface speed of the work measured in feet per minute.

RADIAL DEPTH OF CUT (R. D. C.) is the amount the wheel is fed into the work at each reversal of the table and is equal to one-half the theoretical reduction in work diameter. Radial Depth of Cut is measured in thousandths of an inch.

The **GRAIN DEPTH OF CUT** is the theoretical maximum thickness of a chip of metal produced by a single cutting grain protruding from the bond on the face of a grinding wheel. Each cutting grain on the revolving wheel starts its cut tangent only to the cylindrical work-piece revolving in an opposite direction. However, as this cutting grain moves down from this initial position of tangency, the work moves around, and thus the grain cuts deeper and deeper until it leaves the work and removes its chip. The Grain Depth of Cut is the maximum depth penetrated by the grain under the given conditions of wheel speed, work speed, and radial depth of cut. With a given production, change in the Grain Depth of Cut, is observed by a

change in wheel wear, the greater wear indicating a greater Grain Depth of Cut. (See diagram 1.)

By **PRODUCTION** is meant the amount of metal removed by grinding for a given period. It is usually spoken of as cubic inches per minute or, if larger units are required, cubic inches per hour.

The **ARC OF CONTACT** between a grinding wheel and a cylindrical work-piece is the length of that part of the wheel's periphery that is in contact with the work. This length depends on the diameter of wheel, diameter of work, and the amount the wheel is fed into the work. With a given size wheel under a given feed, the arc of contact increases with the diameter of the work. Thus the arc of contact is one thing, and the width of wheel cutting is another thing—although some call the latter the "contact."

Note: All deductions and conclusions apply only to "roughing work" in cylindrical grinding.

General Conclusions

An increase in production—provided the wheel is cutting well at the start, is not too hard for the job, and the piece being ground is rigidly supported—is more economically obtained by *increasing the Radial Depth of Cut rather than by increasing the work speed*. This refers to situations where increasing the R. D. C. is not prohibited by the frailty of the work or by

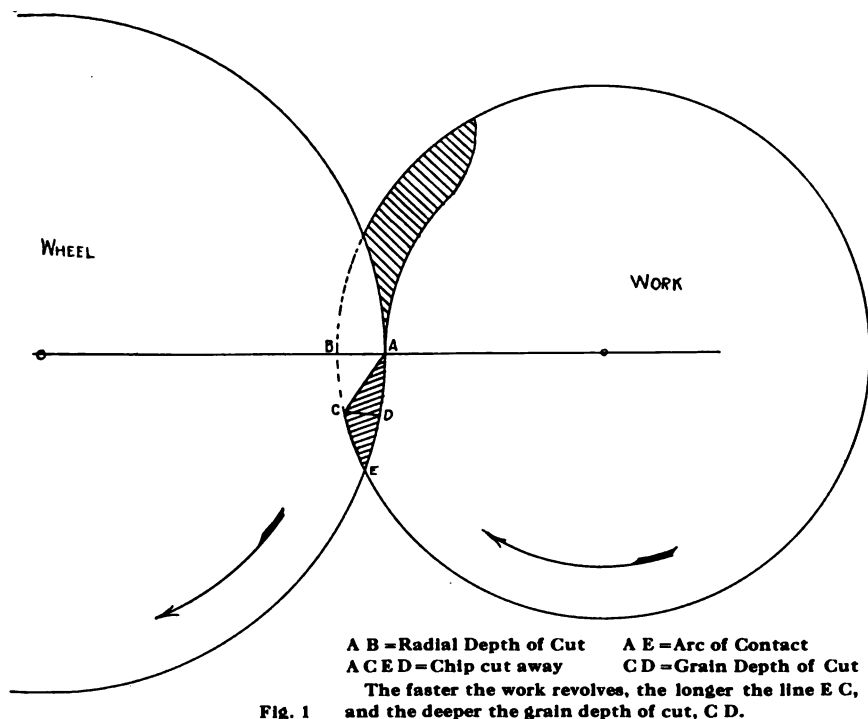


Fig. 1

the large diameter of the work requiring more power than the drive is capable of delivering.

Specifically, it was found that:

1. An increase of $4\frac{1}{2}$ per cent in R. D. C. causes an increase of 1 per cent in wheel wear; and

2. An increase of 1.3 per cent in work speed causes the same 1 per cent increase in wheel wear.

Therefore, it is concluded that a change in work speed is more than three times as influential in affecting wheel wear (or G. D. C.) as is a proportional change in Radial Depth of Cut.

Provided a wheel is acting too hard for the work at hand, the wheel may be made to wear faster and thus act softer by increasing the work speed and reducing the Radial Depth of Cut a like amount. In this way production is not materially affected, and a better cutting action is

obtained by increasing the Grain Depth of Cut of the abrasive particles.

If a wheel is wearing away too rapidly on a given job, the wheel wear may be reduced and the production maintained by decreasing the work speed and increasing the Radial Depth of Cut in the same proportion. Thus, the effect of a too rapid wheel wear and too large Grain Depth of Cut is eliminated by changing the condition causing this excessive wear. The increase in Radial Depth of Cut necessary to maintain production tends to increase the wheel wear but little. For example, if on a 2" bar of soft steel making 35 surface feet per minute under a Radial Depth of Cut of 0.0005" (0.001" feed) the wheel wears away too rapidly, decreasing the work speed to about 25 surface feet per minute and increasing the Radial Depth of Cut to 0.00075" (0.0015" feed) will keep production nearly constant and over-



Diagrammatic Analysis Showing Factors Influencing Grain Depth or Cut.

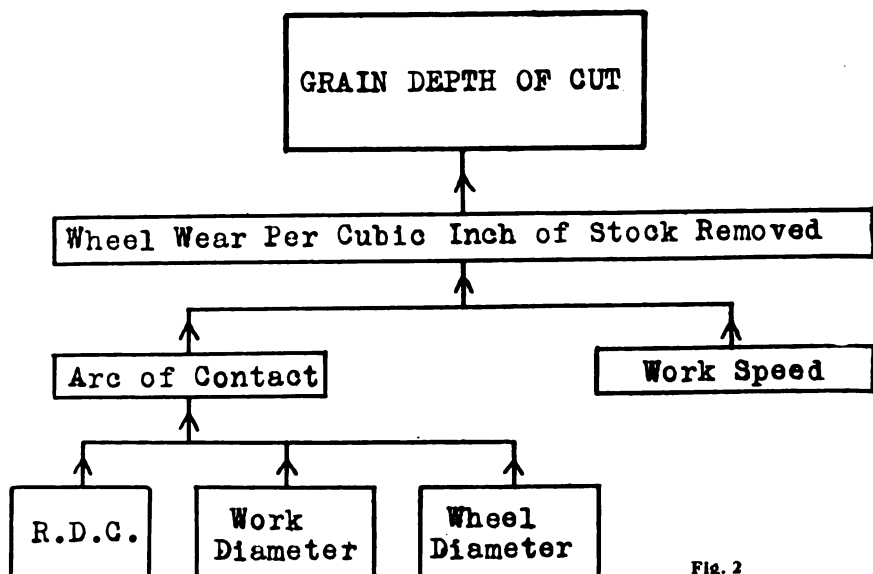


Fig. 2

come the effect of a too rapid wear. (This change in feed corresponds to a change of from four to six notches on the feed wheel of a Norton cylindrical machine.) *These changes merely decrease the Grain Depth of Cut existing and adjust it more accurately to the work at hand.*

It has been proved by a large number of check tests that the following statement from Mr. George I. Alden's original thesis is true:

"If a wheel is working well on a given diameter of work and is then tried on work of a larger diameter at the same surface speeds of wheel and work and at the same Radial Depth of Cut (thus keeping the same production), the *Grain Depth of Cut will be diminished*, the length of arc increased, the area of bond presented to the surface of the work increased, and the bond will not wear away as fast as it did on the smaller diameter of work."

The following table is a complete verification of this statement.

TABLE 1

Constant Wheel Speed, 6,000 S. F. P. M.
Constant Radial Depth of Cut, 0.001".

Work Dia., In.	Arc Contact, In.	Work Speed, Ft.	Production Per Hour, Cu. In.	Wheel Wear Per Hour, Cu. In.	Wheel Wear Per Cu. In. of Stock Re- moved, Cu. In.
1.09	0.033	32.0	20.5	1.69	0.083
2.15	0.044	31.4	20.7	1.66	0.080
3.06	0.051	32.2	21.7	1.37	0.064
4.28	0.058	33.0	22.6	1.29	0.057

As we know the ratio of wheel wear to stock removed is a measure of Grain Depth of Cut, we see from the above table how the work speed should have been increased for each succeeding diameter, provided the wheel was cutting correctly on the 1.09" bar. (See figure 2.)

The big point to remember is—when



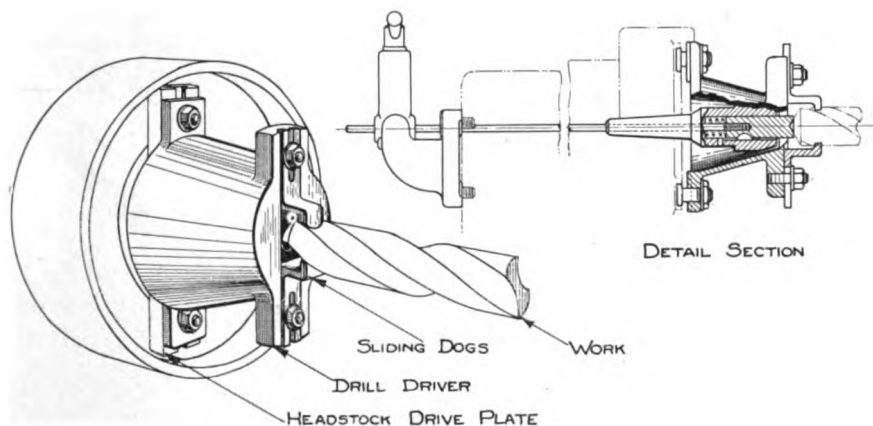
you go from smaller to larger diameter work in rough cylindrical grinding, you should *increase the surface speed of your work* (at the same time decreasing your R. D. C. or feed the same per cent) until the wheel cuts as well as it did on the smaller diameter work. This is conducive

to better cutting action and more economical use of abrasive. Once you have found by experiment a satisfactory G. D. C. on a particular operation, try to keep to it when the work diameter changes, by making the proper adjustment in work speed and feed as suggested in this article.

Grinding Kinks

By HOWARD W. DUNBAR

Twist Drill Driver



The fixture illustrated above is a means for supporting the lip end of a twist drill in a grinding machine so that the shank of the drill can be ground either straight or taper. In the grinding of the straight shank the drill is pressed up against the spring center illustrated here by the foot-stock center. When the driving shanks properly engage the lips of the drill the lever at the back end of the headstock is tightened up, which fastens the female center and provides for a support for the drill while grinding.

The tangs which engage the fluted portion of the drill for driving are adjustable

to take different sizes of drills. This fixture can be fastened to the regular face plate of a standard machine.

When grinding taper shanks in order that the taper will be located in exactly the same relation to the wheel, as each drill is placed on the centers, a special locating attachment is necessary on the footstock. This will be illustrated in a later issue, but this spring center in the headstock is necessary and more convenient in either method of grinding.

We will also illustrate in a later issue means for supporting the drill while grinding the fluted portion.

Polishing and Finishing Machines

The Blevney Patent Two-belt System Meeting with Success—Alundum a Factor of Production and Finish

A recent development in the light grinding, polishing, and finishing fields that has already proved to be a factor in increasing production and reducing expense is the Blevney patent two-belt cushion system. The polishing and finishing machines employing the Blevney patent two-belt system are not limited to the field of finishing metals, but are meeting with success on rubber, fiber, wood, brass, and other materials.

The Blevney machines are in competition with the usual method of polishing and finishing with "set-up" wheels. The Blevney system represents practically the only improved method of polishing and finishing that has been developed in many years and has met with surprising success in connection with increasing production. The productive powers of the Blevney machines are made possible through the use of patent two-belt system. There is a corrugated leather cushioned belt that runs at practically 7,000 feet per minute and a cloth abrasive finishing belt which runs over the former and operates at a slightly increased rate of speed due to the enlargement of the driving pulley which is increased in size by twice the thickness of the cushion belt, the increase in speed being about $1\frac{1}{2}$ " on each revolution of the main pulley. The manufacturers of the machines make the claim that by providing a chip clearance, disposing of the chip immediately as it is cut, the machines are able to work faster and better than would be possible by the old methods which permit the embedding of the chips into the abrasive and interference with cutting.

The Blevney machines are furnished in different types and are consequently adaptable to a large variety of work.

The machine illustrated by Fig. 1 is designed to do such work as it has been

customary to handle on the ordinary set-up or buffing wheel where the work has been held to the wheel by hand. This machine has a wheel of a patented construction and an abrasive belt running

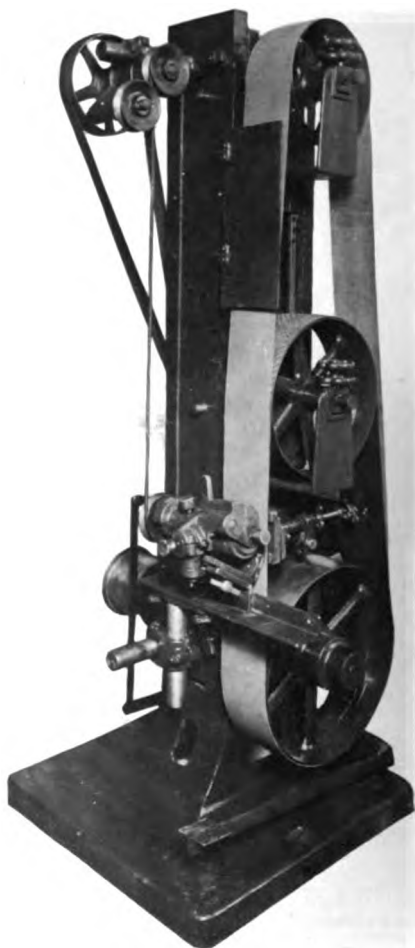


Fig 2

[DECEMBER, 1918]

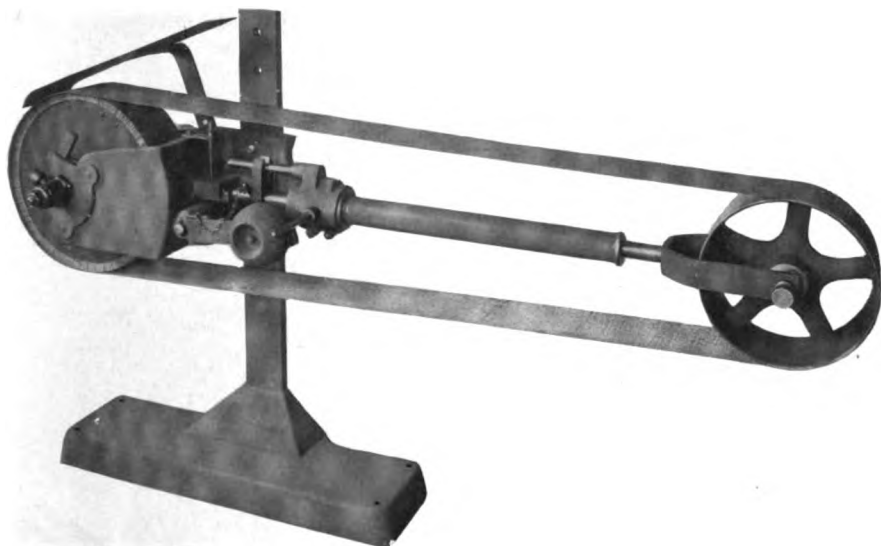


Fig. 1



Fig. 3

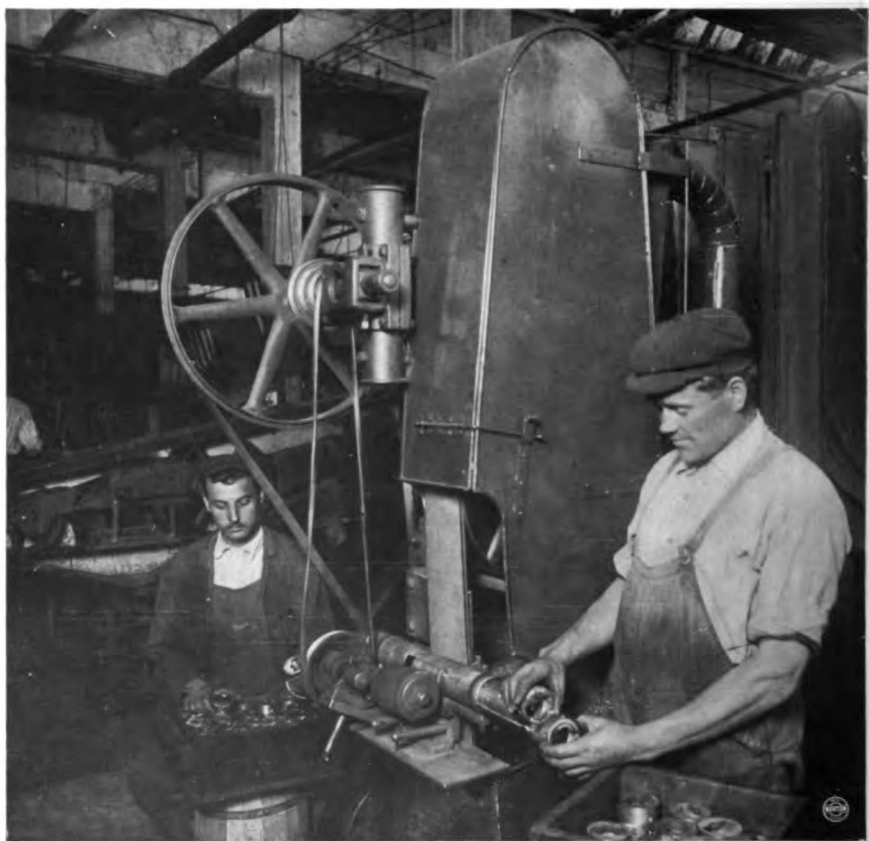


Fig. 4

over the wheel. The patented cushion wheel is made up of a cast-iron hub supported by two flanges that are fitted by leather blades.

Fig. 2 is a vertical abrasive finishing machine with power feed attachment for tubes and cylindrical pieces. This type is adapted for a wide variety of polishing and finishing. It has a capacity for round stock from $\frac{3}{8}$ " to 2" diameter. Its capacity for hand work is anything within range of belt and holding ability of operator. A special attachment is made for this type of machine for polishing tubing, the attachment being equipped with an auto-

matic feed and a heavy fixture for holding the tubing. It is intended for polishing tubing and round work of all kinds, whether the material be steel, brass, rubber, or anything that requires polishing. It has a remarkable capacity for tube polishing, the rapidity as compared with hand methods being several times greater.

Another type of this machine consists of a heavy, substantial cast-iron frame of the box pattern on which is mounted a polishing head with three pulleys over which the corrugated leather and cloth abrasive belts are run. These pulleys are operated in boxes and frames having suit-

able adjustment for controlling the travel of the belts, with provision for automatic regulation of belt tension. It is a production machine for finishing flat or round surfaces in great variety.

Fig. 4 is a photograph of the vertical finishing machine in operation, showing two workmen engaged in finishing the circular surfaces of die collets. One operator is feeding the collets, which are $4\frac{1}{2}$ " in diameter, with $\frac{1}{2}$ " face, through a tube hopper, the power of feed roll taking each piece past the finishing belt and feeding to the operator on the feeding-out end. These two men are doing more work in a day than was possible by the old method in a week.

In Fig. 3 we see one of the other types of machine in use where the flat surfaces of these same die collets are being finished. This machine is furnished with a sectional flexible platen which this operator has removed, substituting a fixed platen, and is surface finishing the die collets one at a time. The builders of the machine would recommend doing at least four of these parts at one time with the regular turret and flexible platen in place.

The Norton abrasive material well known by the trade mark "Alundum" is no little factor in the success of the two-belt system. The good polishing qualities of this abrasive aid in effecting high production records and quality of finish.



Norton Sales Representatives of the Chicago District

W. N. Jove; C. L. Southard; W. H. Warner; H. K. Clark; C. B. Yeomans; G. W. Thomson, District Manager; J. B. Eckstedt; E. B. Cutter; C. H. Cutter; W. F. Bretschneider.



Little Known Facts About Grinding

BY HOWARD W. DUNBAR

Wheel Feeds

It is a noticeable fact that most grinding machine operators have a little knack in the method of feeding the wheel into the work. They cannot always tell you just how or why they feed in a certain way. This we know as the grinding machine operator's art, which is governed by his intuitiveness. It is a part of the grinding operation which cannot be taught to the operator; he must learn it from experience.

There are, however, a few rules which, if followed, will more readily bring about satisfactory results both in production and finish. To begin with, the strength of the cutting particles and the strength of the bonding material in the wheel are effective only up to the limit of their ability to remain in place and withstand the work and shock upon them when grinding. The ability of the wheel to retain the character of face with regard to sharpness or smoothness, as well as the ability to retain its accuracy to a true cylinder, depends upon the skill of the operator when feeding this wheel into the work. It can therefore be readily understood that an operator who carelessly feeds the wheel into the work, imposing more strain upon grain particles, causes them to become loosened. Consequently, they fly out before they have actually served the proper length of time as a cutting medium, wear out, and become useless.

By this action of breaking up the wheel face, which is always done more or less unevenly, the correctness of the face of the wheel as relating to a cylinder is destroyed. The character of face put on the wheel by dressing or truing with the diamond is also lost, so that the production is affected, the life of the wheel is

affected, and likewise the quality of finish. Feeding the wheel into the work in large amounts or varying amounts at different times gives this same result.

Each wheel, related to its speed of revolution and the speed of revolution of the work which it is grinding, is good for a given amount of feed when certain results and conditions are desired. To violate such fixed laws means that the maximum efficiency of the wheel must naturally suffer. When an unthinking operator feeds the wheel irregularly into the work one time half a thousandth, another time a few thousandths, and so on, indifferent results must be expected.

Norton machines are all provided with automatic means for advancing the wheel a predetermined amount. All of these mechanisms are adjustable so that the exact number of thousandths or fractions of a thousandth that the wheel is to be fed into the work can be prefixed, and at each interval of advance the exact and correct amount can be accomplished, bringing about a uniform amount of work for the wheel to perform in a given period, effecting increased production, increased wheel life, and materially improved quality of finish. A safe rule to follow is to use these automatic feeds whenever possible, whether it be an experienced operator or a beginner. It is realized, of course, that there are occasional operations where a delicate touch or hand feed is necessary to produce a definite result; but this can only be accomplished by one who is thoroughly familiar with the laws governing such conditions, and who by previous experience understands instinctively just how to feed the wheel to produce satisfactory results.



“Comy” Brown, the Friend of Southern Grinding Wheel Users

Comegys Brown, Jr., whose territory covers Alabama, Arkansas, Tennessee, Mississippi, Louisiana, and Texas, has been the Southern representative for the Norton Company since 1916. He is a native of Baltimore, Md., and to this fact may be attributed his adaptability for the territory in which he is located.

After attending the public schools in his native city, “Comy” went to Newark, N. J., where, while still in his teens, he entered one of the large manufacturing concerns. Much of his valuable, first-hand knowledge about the grinding game was obtained in this school of “practicality,” for he spent considerable time in the operation of different types of grinding machines. He was not blind to the advantages of a general education, however, and during this period attended night school on the side. His practical experience in operating grinding machines, coupled with his general cultural education, fitted him for entrance to Pratt Institute in Brooklyn, where he elected the course in engine design. Upon graduation from Pratt, in 1915, he came at once to the Norton Company, Worcester. Here he entered the training course, where he remained for more than a year.

His early training proved at this time



COMEGYS BROWN, Chattanooga, Tenn.

of particular advantage to him in becoming familiar with the business end of the grinding-wheel industry; and the business knowledge added to his technical knowledge and practical experience has aided in making him a reliable representative for both the Company and the grinding-wheel users of the South.

It is much easier in cylindrical grinding to grind with steadyrests than without them. Less care is required and less effort exerted in accomplishing definite results. Steadyrests mean increased production, greater accuracy, and finer finish.



Abstracts from Current Articles Pertaining to Grinding

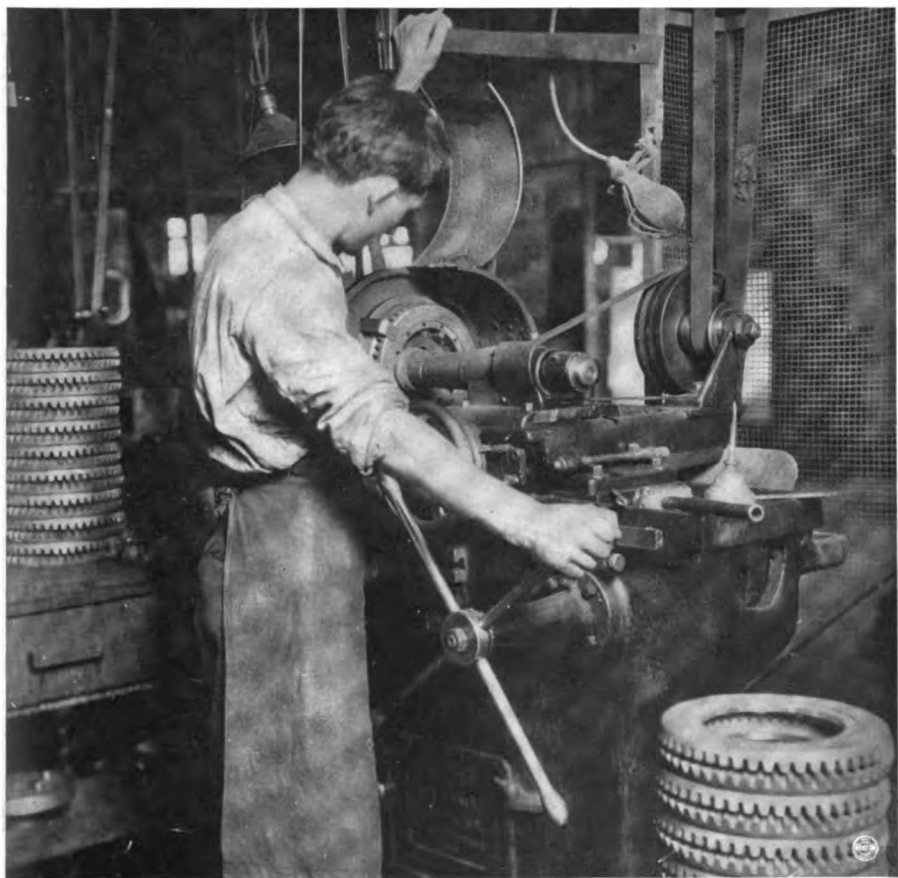
Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

- Center Grinding Attachment. *Machinery*, December, 1918, page 348. Illustrated.
- Heald No. 65 Cylinder Grinder. *Machinery*, December, 1918, page 360. Illustrated. Manufactured by the Heald Machine Co., Worcester, Mass.
- Fischer Profile Grinding Machine. *Machinery*, December, 1918, page 366. Illustrated. Marketed by the Fischer Machine Co., Philadelphia, Pa.
- U. S. Electrical Bench Grinding Machine. *Machinery*, December, 1918, page 368. Illustrated. Made by the U. S. Electrical Mfg. Co., 459 E. Third St., Los Angeles, Cal.
- Setting a Universal Machine to Grind Parallel Holes. *American Machinist*, December 5, 1918, page 1046. The writer claims that the procedure described is rapid and always gives accurate results.
- Grinding Knives Without Removing from the Head. *Woodworker*, November, 1918, page 37. Illustrated. How an attachment on a pedestal grinder permits grinding irregular-shaped knives right on the head. The grinder is made by the S. A. Woods Machine Co., and the device is used at the Stout Lumber Co., Thornton, Ark.
- Supplementary Top Plate Invaluable for Holding Irregular Pieces for Grinding. *Heald Herald*, November, 1918, page 51. Illustrated. A summary of the advantages of using extra top plates for holding parts with thin walls, and an explanation of the illustration.
- Grinding in Locomotive Shops. *Railway Mechanical Engineer*, November, 1918, page 629. Illustrated. The writer explains how internal, cylindrical, and surface grinding machines may be used most successfully in railway work.
- Special Reamers for Correcting Chattered Surfaces. *American Machinist*, November 21, 1918, page 950. Illustrated.
- The illustrations show two devices for grinding reamers.
- Grinding Leather. *Canadian Machinery*, November 21, 1918, page 601. A brief account of the grinding of leather in a case of emergency.
- Grinding; Its Utility in the Modern Shop. *Canadian Foundryman*, November, 1918, page 42. The author aims to remove some "erroneous ideas as to the sphere of action of the grinding machine and as to the principles and practice of the grinding processes" which are still prevalent.
- Making Molded Bakelite Products. *Machinery*, November, 1918, page 187. Illustrated.
- Multiple Cam-Grinding Attachment. *Machinery*, November, 1918, page 214. Illustrated. Description and method of using this attachment recently patented in London.
- Blevney Vertical Abrasive Finishing Machine. *Machinery*, November, 1918, page 272. Illustrated. Description of a machine manufactured by the Blevney Machine Co., Greenfield, Mass.
- Hand Versus Power Feed in Surface Grinding. *American Machinist*, November 14, 1918, page 901. The writer of this article claims that more and better work is done when the toolmakers are compelled to feed by hand. More work is done by this method because the workman does not enjoy the grinding operation and will try to get the job done as quickly as possible. Better work results because coarse feeds and lighter cuts take the place of the fine feeds and deep cuts which prevail when power feeds are used.
- Valley City Wet Tool-Grinding Machine. *American Machinist*, November 14, 1918, page 915. Illustrated. Description of a machine made by the Valley City Machine Works, Grand Rapids, Mich.

GRITS and GRINDS

January

1919



Facing Counterbored Seat of Differential Gear
Diameter of Counterbore $6\frac{3}{4}$ "

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Grits and Grinds

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Recent Developments in Internal Grinding With an Eccentric Arm Cylinder Grinder

S. J. BELL

Until quite recently, it has been almost universal practice to bore and ream to the required dimensions all holes of diameters exceeding those of the automobile cylinder and up to 12". Recently, tests have been carried out on the internal grinding of large diameter holes with much success; and from results obtained, this method should come into greater use as a satisfactory way of doing this particular work.

Figure 1 shows a large hole in hardened steel which was ground very accurately and efficiently on the Heald cylinder grinder shown with an Alundum vitrified wheel. Owing to the irregular shapes of certain castings and forgings having holes to be finished to required limits, difficulty is often experienced in mounting the part on the boring mill bed. Figure 2 shows the successful grinding of hardened steel bushings in a locomotive side rod. This is a new development in large hole grinding that shows the possibility of more refined work in the railroad field and with parts which are too bulky to be revolved.

The adaptability of the cylinder grinder to large hole grinding is further illustrated in figure 3. This shows a special casting of irregular shape which accommodates itself quite readily to the table of the standard cylinder grinding machine. The

hole in question is 12" diameter and the wheel used is $8 \times \frac{3}{4} \times 1\frac{1}{4}$ ".

The speed of the grinding wheel on these cylinder grinders should range between 5,500 and 4,500 surface feet per minute in order to obtain the best results. Speeds lower than this call for harder grades of wheels, which in turn retard production because they are not as free cutting as softer wheels operated at the speeds recommended. The usual size of wheel mounted on a cylinder grinder of the type shown in the illustrations is $3\frac{1}{2}$ " or 4" diameter. When larger diameter wheels are required, a pulley proportionately larger than the standard one should be put on the machine so that the spindle speed will be properly reduced.

The diameter of the grinding wheel is, of course, determined by the size of the hole to be ground; and while there is no direct rule governing this, a fair rule to follow is to have the grinding wheel from two-thirds to seven-eighths the diameter of the hole. Three-quarters is an average usually recommended in ordinary practice.

One of the most important features in obtaining good work on a cylinder grinder is proper and timely truing of the wheel. It is essential that the wheel face be kept true and straight at all times. This is

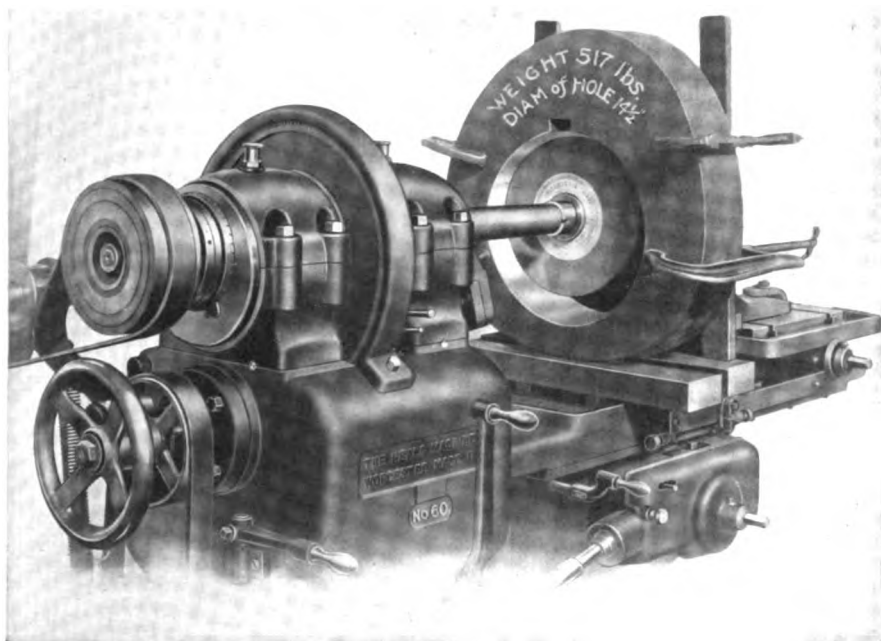


Figure 1. Grinding $1\frac{1}{2}$ " Hole in Large Hardened Steel Cam

accomplished by means of the diamond tool clamped rigidly in a fixture belted to the table of the machine or to a jig or holding device, if this is more feasible. The grinding wheel should be presented to the diamond tool so that the diamond operates slightly below the center of the wheel and very light cuts should be taken in order to preserve the diamond.

The importance of selecting a wheel of correct grain and grade for the particular job is evident as grit and grade affects to a very large extent the productive capacity of the machine and the quality of the work. If the wheel is too hard, it will rapidly glaze and consequently cut slowly, requiring frequent dressing with corresponding short life. Besides low production result-

ing, the holes are very liable to be out-of-round and not straight.

It is advisable to use wheels of comparatively open structure and sufficiently soft to be able to cut freely and yet hold up under fairly heavy pressure. The grits commonly employed for internal grinding on a cylinder grinding machine of the type shown in the illustrations range between 30 and 46. Finish requirements, diameter of hole to be ground, and amount of material removed determine grit size largely. The finish depends not wholly upon the makeup of the wheel but rather upon the attention paid to truing preparatory to the final traverse of the spindle.

The grades, of course, depend upon the physical properties of the metal ground,

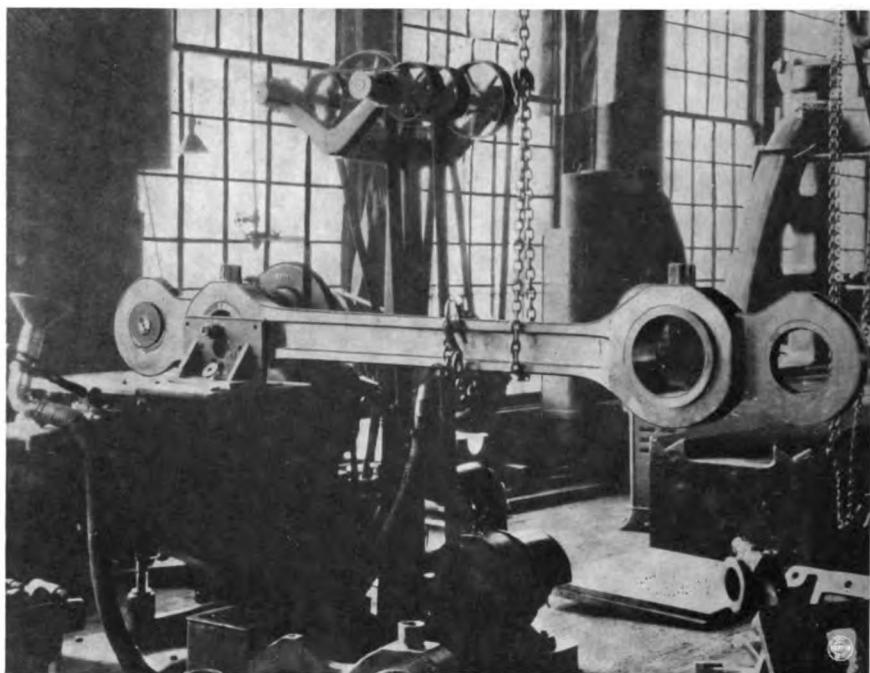


Figure 2. Grinding Hardened Steel Bushing in Knuckle Joint Pinhole of Locomotive Side Rod

also the arc of contact, wheel speeds, feeds employed, and so forth. Rather general classification can be made as follows:

Hardened Steel,	Grades G or H
Soft Steel,	Grades I or J
Cast iron,	Grades H, I or J

Cast iron varies so much in its machining qualities that it is impossible to recommend a definite grade without actual trial. Grade H will usually suffice for hard cast iron, I for medium, and J for the soft gray iron.

A further application of grinding to railroad shops is shown in figure 4. Here we have a cylinder grinder grinding the eccentric rod connection on the bottom of a link

used in the Walschaert valve motion. A case hardened bushing is pressed into the link and then ground out true. For wheels from 1" to 3" diameter, special quills can be easily designed by the grinding machine manufacturer to be attached to the regular spindles. These quills will take care of the smaller holes, say up to 3" diameter, and from 3" to 12" diameter holes are handled by the regular spindles.

Probably the most important step toward efficient internal grinding is a well bored hole. The hole, of course, does not need to be smooth but it should be true—that is, round and straight. In other words, the hole should be bored to required

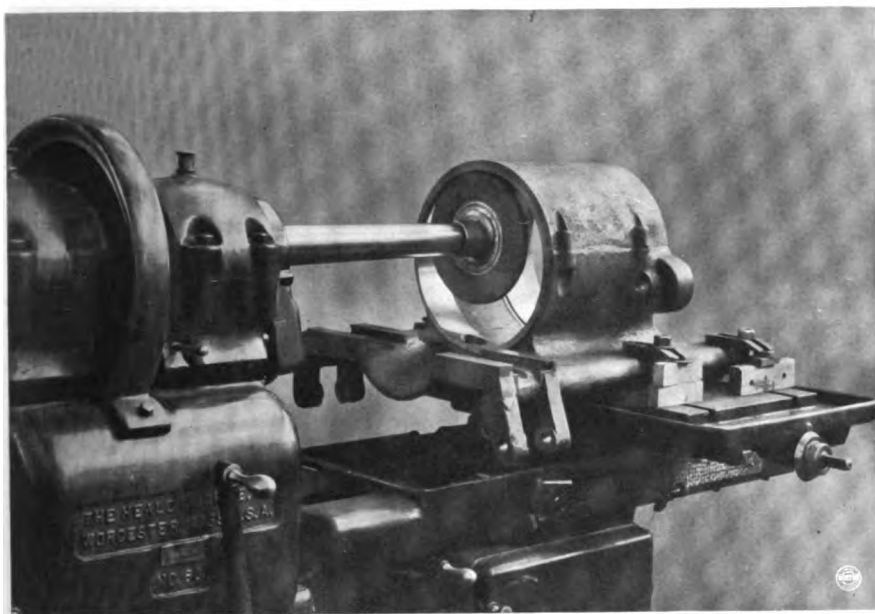


Figure 3.

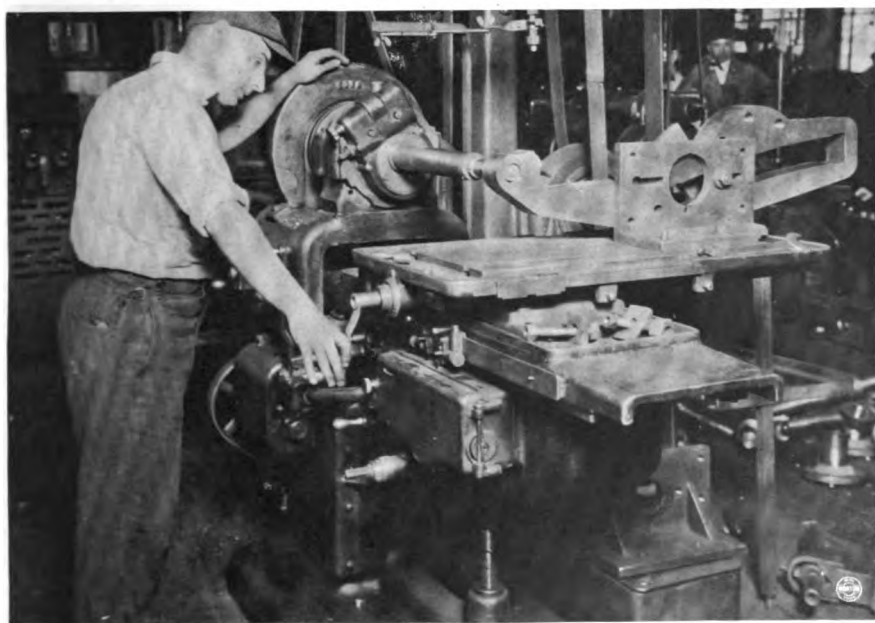


Figure 4.



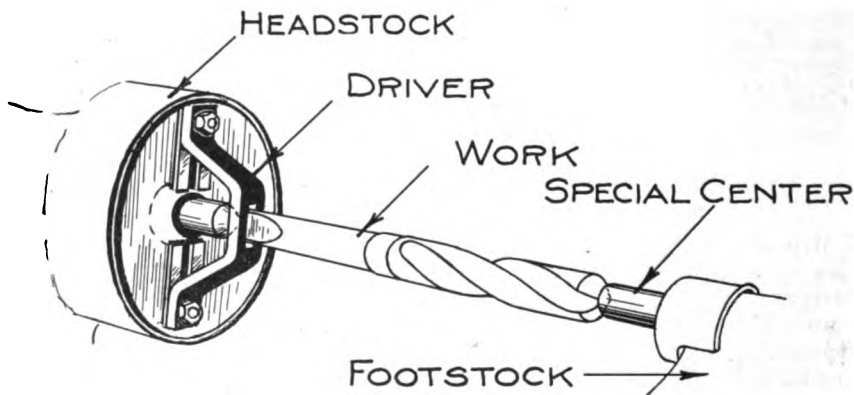
dimensions, leaving from .010" to .015" to be removed by the grinding wheel. The closer a hole can be bored, the less time is required to obtain the finished product on the grinding machine.

The cylinder grinder has demonstrated its ability to grind the bores of cast iron automobile cylinders, the steel sleeves of the Liberty airplane motors, and work of this nature. We believe that a big field is now open to manufacturers of heavy machinery and equipment which they cannot

afford to neglect looking into at least. In railroad shops especially, there is a splendid opportunity to improve the quality on many of the internal machining operations with resulting improvement in rolling stock in general. We shall be very pleased to assist in the development of means whereby the cylinder grinding machine may be used to increase your production and turn out a better quality of work.

Grinding Kinks

By HOWARD W. DUNBAR



The illustration above is a supplement to the illustration in last month's bulletin showing the method of holding

twist drills for grinding on the flutes.

The cut is sufficiently clear in itself to require no further explanation.

Wheel Selection and Operation

NOTES FROM THE FILES OF SALES ENGINEERING DEPT.

Semi-Steel

The composition and physical properties of semi-steel are not generally understood, and this often leads to difficulties in selecting proper grinding wheels. Semi-steel is a cast iron alloy and must be classed as cast iron, although it is really of a little higher grade and somewhat stronger than ordinary gray iron. Table 1 will show its chemical properties as compared with those of gray iron:

TABLE 1

Analysis of Gray Cast Iron and Semi-Steel

	Silicon, %	Graphite, %	Combined Carbon, %	Total Carbon, %
Gray cast iron,	2.00	3.10	0.30	3.40
Semi-steel,	1.75	2.80	0.40	3.20

Although semi-steel could undoubtedly be made from materials which are commonly used for cast iron, it is practically always produced by charging with these a certain amount of steel scrap to bring about the lower silicon, phosphorus, and total carbon desired.

Because steel has a higher tensile strength than cast iron, many have inferred that it was the steel addition which made semi-steel stronger than the ordinary gray cast iron. The rather unfortunate name, semi-steel, apparently was given because of the steel used and the intermediate strength which the resulting product possessed. However, during

the melting down of the charge the steel scrap becomes molten and its constituents merge with those of the other iron material charged.

The physical properties of the steel which have been used in the mixture have been entirely obliterated during the melting process. You will note from Table 2 that the tensile strength of semi-steel is increased somewhat over gray cast iron, but that it is still far below that of cast steel. Its weakness under shock is also shown in the number of blows required to break a bar of given size. Its resistance to shock is only very little greater than cast iron, only half as much as malleable cast iron, and one-eighth as much as cast steel.

TABLE 2

Alloy	Tensile Strength, lbs. per sq. in.	Number of Blows to Break
Cast iron (gray),	23,400	7
Semi-steel,	35,050	11
Mall. cast iron,	37,140	22
Cast steel,	72,120	92

This places semi-steel quite definitely in the cast iron class, and Crystolon wheels will be found more efficient generally than wheels composed of regular Alundum. In a few cases, however, regular Alundum and No. 66 Alundum have been used to good advantage on semi-steel piston rings and such articles.

Billet Grinding

BY R. M. JOHNSON

With the great increase in the production of steel billets, the finishing process becomes relatively of increased importance. This operation consists of first removing the scale and then all the cracks and flaws. Cracks left in the billets make seams in the finished plates, tools or whatever the final product may be and must be completely eliminated to produce a high class material.

There are two different methods used for this operation—grinding and chipping. Roughly, all carbon steel containing more than 60 points of carbon and most alloy

steels containing tungsten and manganese are ground. It is common practice to chip all steels which are soft enough to allow the chisel to penetrate easily. Upon investigation we find the reason usually given for chipping is that it has always been done that way.

By chipping the seams can be removed from the soft-billets rapidly, but not as thoroughly as by grinding. The chisel acts as a peen and covers up the bottom of the seam and also of adjacent seams by forcing the metal together. Another disadvantage is that the chisel makes deep



grooves with sharp corners. When two such grooves are close together a ridge is formed; and when the billets are rolled into commercial shapes, these ridges lap over the sharp corners of the grooves, leaving seams which have to be ground out later. This makes additional work necessary.

When a high grade product is required, chipping is a bad feature of the manufacturing process. To the inspector the cracks may have been completely removed, the bottom of each groove made by the chisel being smooth and entirely free from flaws. Due to the peening action of the chisel, however, many of these are merely covered up and during the following rolling operation may develop into serious flaws.

These difficulties can be eliminated by the use of a grinding wheel for "cleaning up" the billets. The wheel grinds the metal clean from the cracks, and there is no tendency of the wheel to cover the crack with metal, provided a wheel of the proper grain and grade is being used.

This leads us to a discussion of the grain and grade used for this work. Wheels should be chosen upon a basis of material removed per wheel and per unit of time and not on a basis of total tonnage of billets ground or hours-life of the wheels. Total tonnage figures are misleading, for although in the case of some billets only 5% of the total weight is ground off, we have found extreme cases where as high as 50% is removed. On a particularly bad run of billets a wheel may snag only 1,000 pounds, whereas on a run 4,000 pounds may be the production. In the former case, however, the wheel may be actually removing a greater amount of material than in the latter, and, if so, it is obviously the better wheel regardless of the total pounds of billets ground. The same holds true for comparison on the basis of hours of wheel life.

Some very interesting results will be obtained if a comparison of wheels is made, keeping a record of the time consumed



High Production with a Medium Hard Wheel



Row of Swing Frames Cleaning Nickel Steel Billets

during grinding, the pounds of metal ground off, and the earnings of the operator. The material removed will have to be obtained by weighing each billet before and after snagging. This is somewhat inconvenient, but during a comparatively short test the information obtained will be worth the effort expended. In order to make a practical investigation of the cost of each pound of material removed, the three factors mentioned above should be recorded. The total wages, wheel cost, and overhead can be calculated and the cost determined.

Several studies of this kind have revealed considerable valuable information, and the laws governing the use of snagging wheels for billet grinding are as a result more clearly understood. Using medium hard wheels, the life is considerably reduced compared with that obtained when very hard wheels are employed. The material removed per wheel is also reduced, but in a much lower proportion. For instance, one individual test showed a decrease in life of 60%, while the material removed decreased only 30%. This amounts actually to an increase in hourly production of about 80%. Even though during a given period more than twice as many wheels were used, the cost of removing each pound of steel was actually reduced 30%.

[DECEMBER, 1918]

Besides a decrease in cost, the soft wheel has several other advantages—

1. The grinders, who are working on a piece rate or bonus system, make a larger week's pay.

2. Due to this increase and also the ease with which the material is ground, labor troubles due to slow-cutting wheels are eliminated.

3. The production is greatly increased without the necessity of increasing the plant equipment or number of workmen.

4. Hard wheels, owing to the large amount of heat developed, have a tendency to cause the cracks and seams to become deeper instead of being ground out. This is noticed most frequently when high speed steel is the product.

The two illustrations accompanying this article show a fast cutting Norton wheel being used on swing frame machines for cleaning high speed steel billets. The operator reports that Norton wheels are used because "they cut quickly and with a minimum of danger of breaking, owing to the good quality of the wheels."

We have a trained engineer whom we shall be pleased to have call upon any billet manufacturer and make a complete investigation in order to determine the proper wheel for the work. We hope you will make use of this branch of Norton service.

[9]



Little Known Facts About Grinding

By HOWARD W. DUNBAR

Hand Grinding and Machine Grinding

One is likely to confuse hand grinding and machine grinding when thinking of some of the principles that govern the grinding action of a wheel. Now it is quite an important factor in the selection of the right kind of wheels for these two different methods of grinding, and so it seems necessary to point out some of the differences existing between machine grinding and hand grinding, so that these differences can be taken into consideration when grinding problems in either class come before our readers.

Of course, in both methods of grinding, that in which the work is held in the machine mechanically and passed before the wheel mechanically, and the class where the work is held in the hands of the operator and pressed against the wheel manually, the same general principles govern the results that are obtained—that is, the grain depth of cut, the radial depth of cut, the speed of wheel relative to these cuts, the kinds of material being ground, etc., all have their bearing on the resulting grinding wheel efficiency.

In both methods of grinding the construction of the machine plays an important part. The facts that the centers in the machine grinding method, the headstock, the table, the machine itself and all associated parts are heavy, rigid and substantial, and that they absorb vibration and permit of greater power being applied to the grinding wheel, carry equal weight in the hand grinding method where the work rest, upon which the work being ground is placed, is strong and rigid offering a good support in case the work is carried up close to the cutting point of a wheel. There is no chance for vibration

or cramping action if the spindles and bearings are generous in size and well made, and therefore better results are obtained.

There is one factor in hand grinding that does not allow for definite rules to be laid down, and does not permit of the same reasoning that can be applied to machine grinding, and that is the personal element that enters into this operation. Some men become very proficient in hand grinding. They know just how hard to bear on with the work in order to make the wheel cut freely and efficiently. They know just when it is necessary to dress the wheel, to break up the face or surface, in order to produce certain results. They know when the wheel is being burdened with more work than it can do, and they unconsciously and instinctively accommodate themselves to these conditions. They ease up on the depth of cut or pressure that they bring to bear between the wheel and the work, and pass the work over the face of the wheel quickly in order to accomplish certain results. They press or bear on to accomplish certain other results. There is really a considerable amount of art necessary in hand grinding, as well as in machine grinding, but always bear in mind that this personal equation is a factor which may introduce indifferent results or very satisfactory results when work, wheel and conditions may be the same but two different men operate the machine at different times.

The tendency in hand grinding, as in machine grinding, is toward harder wheels. However, in either case, soft wheels are better producers.

Leslie C. Griffin, Only Salesman-Soldier to Become Lieutenant

By the time "Grits and Grinds" readers have had the opportunity of seeing the picture of this young man in Uncle Sam's uniform he will have doffed the khaki and returned to citizen's ranks to take up his duties as salesman in the southern territory of coastwise states which extends from Baltimore, Md., to Key West, Fla.

The Norton Company first made Leslie's acquaintance in 1911, when he arrived in Worcester from somewhere in Vermont to take the training course. He has the distinction of being one of a class of two students in the first course the Company offered for giving concentrated experience in the grinding wheel business. After a year and three months here he toured the New England States in company with Herbert Duckworth, now assistant sales manager, who augmented Griffin's wheel experience with an introduction to salesmanship. New York next claimed his attention, and he remained in that city for a year and seven months, after which it was decided to send him to Baltimore, the headquarters for District 7. During his two years' stay in this section, from 1916 to 1918, he made a fine reputation for himself by developing the district and serving grinding wheel users well.

When the Kaiser failed to sell his services and then tried to force them on the world, Griffin couldn't stand it and decided to do some competitive work. In January, 1918, he was stationed at Camp Devens, Mass., where he was promoted shortly after to the rank of sergeant. The O. T. S. at Columbia, S. C., next claimed him, and after some intensive



**L. C. Griffin, District Manager, With
Headquarters at Baltimore**

training he was promoted to the rank of first lieutenant. His military experience was further supplemented by a period of training at the School of Fire, Fort Sill, Okla. After this he was stationed with the 71st Infantry at West Point, Ky. The armistice intervened, and disappointment in carrying out his overseas project came in the form of cancellation of sailing orders which had him slated for overseas service.

This ends the story of the soldier. There will doubtless be further chapters about the salesman. Further particulars concerning Griffin are that he is unmarried and has no bad habits.



The Significance of Americanization

Americanization now means more than a name. It is a nation-wide movement into which companies and other organizations are entering whole-heartedly in order to increase the value of the foreign individual both to himself and his company and, incidentally, to his adopted country.

Concerns have been quick to see during the past six months that they have on their payrolls in some instances hundreds of workers who may be considered potentialities, either positive or negative. As long as the foreign spoken workman talks his own language to the complete disregard of the current language of the United States, just so long is he going to misunderstand everything American. In such a case he is a liability. Teach him English, the language that places him on an equal footing with his fellow workman,

get him to think "American," and you have a positive potentiality, or an asset.

Teaching the foreign workingman English is not a pretty theory. The companies that have tried it are enthusiastic in its success, for they have come to realize that as long as the barrier of language lies between the employe and the organization, neither the employe nor the organization can get a square deal, for the cause of each is misrepresented through the lack of common understanding.

The experience of the Norton Company in this particular is a happy one. The persons there in charge of the Americanization work find their efforts in behalf of the foreign man met with a willingness on his part to co-operate. The members of the classes are advancing steadily and take keen interest in availing themselves of the privilege to learn English free of charge.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

American Standard Portable Thread Grinding Attachment. American Machinist, December 26, 1918, page 1195. A new attachment marketed by the American Standard Gauge Corporation, 7-8 Chatham Sq., New York City. It is intended for use on gages, taps, and cylindrical work, but can also be used as a center grinder, for face grinding, chucking work, etc.

Stellite and High Speed Steel Compared. Iron Age, December 26, 1918, page 1584. The writer tells about a comparison made of the variation in hardness at different temperatures of stellite and a superior quality of high speed tool steel. The results of some cutting tests on three classes of material are also given.

Cylinder Boring and Reaming. Machinery, January, 1919, page 383. As the

most highly developed cylinder machining methods are found in automobile plants, the equipment and the important variations in practice in these plants are described fully in this article.

Grinding Accurate Profile Gages by Means of Master Plates. American Machinist, January 16, 1919, page 105.

Improvement in Wheel Dressers. American Machinist, January 16, 1919, page 123. The writer tells of a simple device used to prevent trouble caused by the turning of the pin in the ordinary form of wheel dresser.

Grinding Wheels for Woodworking Tools. Wood-worker, January, 1919, page 28. A general account of the materials and processes used in manufacture of grinding wheels and some remarks about the economical use of grinding wheels by wood-workers.

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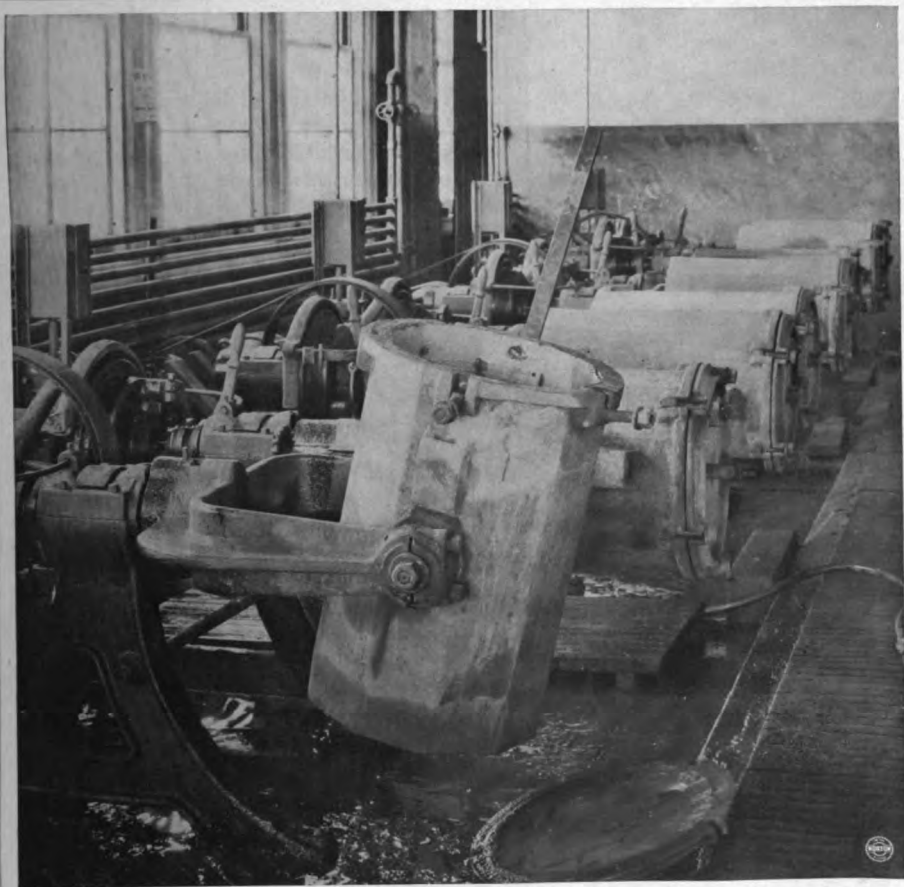
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GRITS and GRINDS

February

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Twin Rumbling Barrels Used in Cast Iron Polishing



Grits and Grinds

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Polishing Cast Iron by Rumbling

By R. M. JOHNSON

It is often necessary to use other methods than the polishing wheel set up with abrasive for polishing irregular shaped castings. This method is very satisfactory where the pieces are straight and regular, but many irregular parts must be polished to prepare a surface that may be lacquered satisfactorily. These castings as well as regular shaped pieces are now being prepared by rumbling in closed barrels in the presence of coarse Alundum grain, steel slugs, and water. A saving of as high as 35 per cent over the old method has been obtained on some castings.

The barrels successfully used by one large concern are of four types:

1. The largest, shown in figure 1, is $5\frac{1}{2}$ feet long by $2\frac{1}{2}$ feet square. The opening in one side is 3 feet by $1\frac{1}{2}$ feet. The barrel is supported at the center of each end and revolves in a horizontal position. This type may be used altogether for large castings, care being taken that no thin walled pieces are included in the load, as the length of fall and weight may cause breakage.

2. The next size is octagonal, $19\frac{1}{2}$ inches in diameter and $29\frac{3}{4}$ inches long. Figure 2 shows in the background several of this type which are operated in the horizontal position similar to the square barrels.

3. The third type is the same size as the above, the only difference being that

these barrels are mounted and operated in pairs set end to end.

4. The smallest barrel is $17\frac{1}{2}$ inches in diameter and $29\frac{1}{4}$ inches long, octagonal in shape and supported at the center of two sides. They are loaded by tilting to a vertical position as shown in the cover illustration. They revolve in a horizontal position, two barrels being set up with a single drive as shown in figure 2.

As an indication of the relative size of the largest and smallest barrels it might be said that the former will hold about six and one-half to seven times more shafting of the given size than the latter. The chief disadvantages in the use of the larger size are the danger of breakage and the fact that the finish is not quite as good as can be obtained with the smallest barrels.

A study was made to determine the most satisfactory slug to use. These are added to fill in the openings between the castings and to add weight to the load. Soft slugs were tried as it was believed that the abrasive would become embedded in the surface and add to the cutting action. It was found, however, that boiler plate punches varying from $\frac{1}{4}$ to $1\frac{1}{2}$ inches in diameter gave most satisfactory results. This material was found to actually assist the abrasive in cutting down the castings, especially after the hard outside scale was removed.

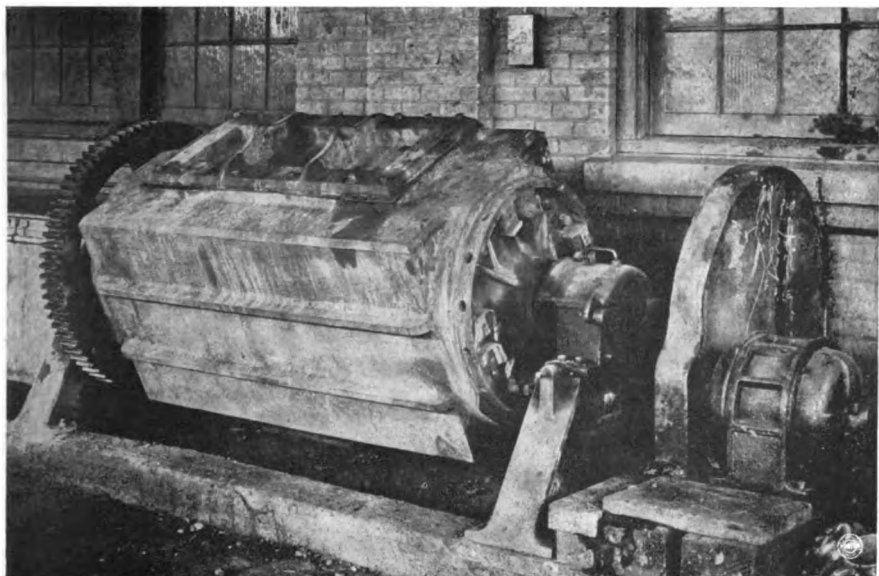


FIGURE 1—Largest Size Barrel in Position for Unloading

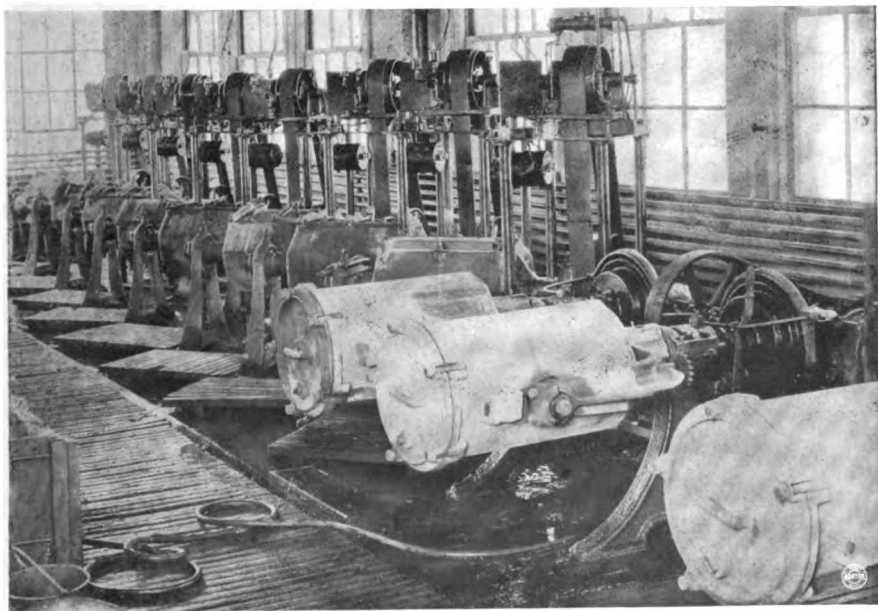


FIGURE 2—Battery of Octagonal Barrels



At first enough water was added to keep the castings clean at all times when they were out of the mixture. It was found, however, on further experimental work that better results are obtained if only enough water is added to make a thin pasty mass when the abrasive has been worn down to a fine powder.

Alundum grain, broken Alundum wheels, Crystolon grain, crude Crystolon, angular grit, and trap rock have been used as the polishing medium. The trap rock and angular grit were both unsatisfactory as they had practically no cutting action. Both the crude Crystolon and Crystolon grain, owing to its characteristic brittleness, broke down to a fine powder and soon lost its cut.

Broken Alundum wheels gave satisfactory results as far as cutting action and finish are concerned. Before using, it is necessary to break them up into pieces one inch or less in diameter and for this reason Alundum grain size No. 4 or No. 8

is cheaper to use and gives very satisfactory results.

When this method of polishing was first used, considerable difficulty was experienced due to severe explosions taking place after the load had been rumbled for some time. This was at first attributed to the use of Alundum, but subsequent tests were run leaving the Alundum out of the barrel. The explosions occurred in the same manner.

An analysis of the gas in the barrel was made, which showed that a large amount of hydrogen was present. This, we believe, was the result of a reaction between the finely divided iron and water, the explosion being caused by a spark igniting the hydrogen.

This danger can be eliminated by blowing air through the barrels at the end of each three or four hours' run. In case compressed air is not available, the barrels should be left open for a short while, so that the gas may escape.

[The Editors wish to thank the "Metal Industry" for the cuts used in connection with this article.]

Arc of Contact

By W. T. MONTAGUE

A well-known general axiom of grinding is "the greater the arc of contact, the softer should the grinding wheel be," and, vice versa, "the shorter the arc of contact, the harder the grinding wheel must be." How many of us have ever reasoned this out in detail?

Given a wheel 18" diameter, 2" thick, of 46 grit, working on a bar of soft steel 2" diameter under a radial depth of cut of .001" (feed .002"), the arc of contact is just .04276" long, to be exact, and so a grade L Alundum vitrified wheel has been found satisfactory under these particular conditions. See figure 1, which illustrates this on a greatly magnified scale. In this contact, approxi-

mately 3-64" long, there may be three cutting grains along the periphery of the wheel or for a 2" wide wheel, say two hundred cutting points at work at one time. In other words, the work is distributed over two hundred tiny cutting tools and good results are obtained.

Now, consider figure 2, which also represents an 18 x 2" wheel surface grinding a bar of the same soft steel. Under a depth of cut of .001", the arc of contact becomes .134" or over three times that in the case of Fig. 1. Now there are between five hundred and six hundred cutting grains at work in a given instant and the work which each has to perform is proportionately reduced. The "grain



depth of cut" (maximum penetration of the abrasive grain) has been decreased. There is not so much rub or strain on the surface of the bond because of this lessened penetration. The wheel does not wear so much. Hence, we say the wheel acts harder.

This harder action usually calls for a softer wheel and so we would probably

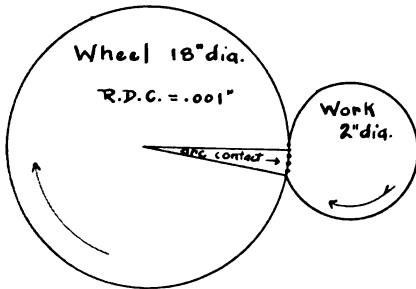


FIGURE 1

say grade J for the surfacing, whereas grade L was satisfactory on the same kind of steel for cylindrical grinding. It is a well-known fact that the surface grinding grades on a planer type machine are one or two degrees softer than those used in cylindrically grinding the same material.

The same reasoning applies to internal grinding. Here we have a greater arc of contact due to the intersection of two concave surfaces and so still softer wheels must be used.

In the case of figure 3, probably grade I would be required to give satisfactory results.

An understanding of this enables us to see why surface grinding grades are

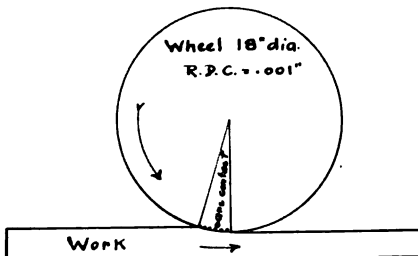


FIGURE 2

[FEBRUARY, 1919]

usually softer than those employed in cylindrical grinding and the internal grinding grades still softer than those used in surface grinding. The same reasoning applies when increasing the diameter of the work ground in a plain cylindrical grinding machine. Figure 4 represents in curve form the increasing arc of contact on an 18" diameter wheel under a radial depth of cut of .001" when the diameter of the work is increased. The larger the diameter of the work, the greater the arc of contact, and the greater the arc of contact, the less the "grain depth of cut." The less the "grain depth of cut," the softer must be the wheel, unless the original satisfactory "grain depth of cut" is restored in the case of the larger work. Then the same wheel can be used successfully.

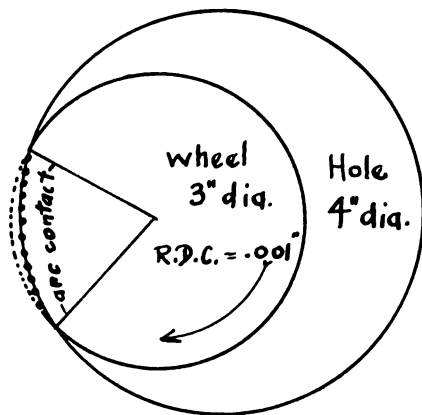


FIGURE 3

How do we bring this satisfactory "grain depth of cut" back? By making each cutting tool on the face of the grinding wheel do more work. How is this accomplished? By increasing the surface speed of the work which presents more metal to the wheel in a given time and decreases the number of cutting teeth available to do this work. Another way is to decrease the speed of the grinding wheel, although this is usually not so readily accomplished as increasing the

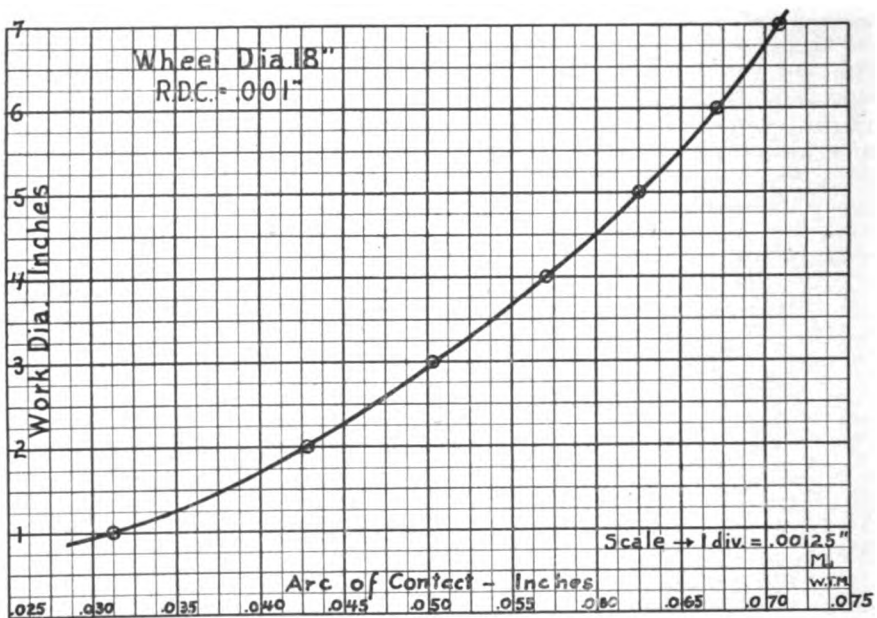


FIGURE 4

speed of the work and it requires a greater change in wheel speed to readjust the "grain depth of cut" than it does in work speed.

This "grain depth of cut" is important. *It is the controlling factor in affecting*

wheel action. Let us get hold of this idea, for the grinding wheel user will be saved many perplexing problems if he thoroughly masters the "arc of contact" question, its relation to grits and grades, and proper wheel action.

Little Known Facts About Grinding

By HOWARD W. DUNBAR

Wheel Service in Cylindrical Grinding

Wheels give service in exact proportion to the intelligence exhibited and conditions surrounding their use. In tests and experiments conducted to determine the factors which made for ideal wheel service and conditions it was developed that when such conditions were ideal the wheel would give a service of approximately 20 cubic inches of steel removed to 1 cubic inch of wear from the wheel.

During the same test certain facts were

brought to light which developed a condition when the wheel was carelessly or ignorantly used of not more than 2 cubic inches of steel removed to 1 cubic inch of wheel wear. Over a long period of time, with varying operating conditions, different operators, and different conditions of the machine, 3 cubic inches of steel were removed to 1 cubic inch of wheel wear. In grinding very large chilled iron rolls 16 cubic inches of chilled iron were re-



moved to 1 cubic inch of wheel wear. On other classes of work such as tool steel bars, ground under normal conditions, there was a wheel service of 10 cubic inches of steel removed to 1 cubic inch of wheel wear.

Because of these varying conditions it is felt that it would be important to the users of machines if they knew the different factors which entered into the amount of service that a wheel could render. Therefore the following list has been compiled.

CAUSES OF WHEEL WASTE

(1) Wheels not in balance. This condition causes the wheel to pound, causes chatters in the work, causes the wheel to cut unevenly, causes vibration which breaks up the wheel face and makes it wear very rapidly.

(2) Wheel too soft for the work.—Where the bonding material is so soft that it will not retain the cutting particles it is evident that the particles are loosened from their setting before they have had a chance to do their full amount of work, and therefore the wheel wears away too rapidly.

(3) Work speed too fast for the wheel grade.—This has the same effect in the grinding action as too soft a wheel.

(4) Insufficient steadyrest supports.—If there is not a sufficient number of steadyrests, the work is not held from vibration and may not revolve about its true axis; it will cut unevenly on the wheel face and cause the wheel to break away and wear out without actually grinding.

(5) Wheel spindle too loose in the bearings.—This again brings about the same condition of vibration, except that it is in the other element; that is, in the actual grinding medium rather than in the work being ground.

(6) Careless hand feeding.—In other words feeding the wheel into the work in irregular distances, .002" at one time

.005" at another and so on, which imposes undue work on the wheel. A uniform rate of feeding is the ideal condition. Use the automatic feeding mechanism wherever possible, so that the same amount of work will be imposed upon the wheel at all times.

(7) Vibrations in the machine or the work.—This may come through improper foundation for machine, poorly erected machine, or a machine which has been abused or in service for a long time and needs attention.

(8) Improper lubrication of the work.—When the wheel is grinding, there is a large amount of heat generated. This heat must be dissipated and carried away by the grinding fluid. If it is not, the work expands unevenly causing wasteful wear of the wheel.

(9) Incorrect speed of work as relating to grade of wheel.—The machine has a considerable range of speed, so that the proper grinding action can be produced by juggling the work speed to suit the grade of wheel being used.

(10) Injudicious truing or dressing of the wheel.—Many operators true off more of the wheel than is necessary. A wheel is dressed to make it cut freely. If the wheel is of the proper grade and the speed of the work is correct, very little dressing is necessary for rough grinding. The wheel will wear away automatically fast enough to present a sharp cutting face at all times. The wheel is trued to produce a desired effect in the finish, and does not necessarily require the truing off of a large amount of the wheel face. All that needs to be done is to correct the face of the wheel, getting all the particles an even distance from the axis of rotation of the wheel.

(11) The use of common dressers or a piece of wheel for breaking up the face of the wheel when dressing.—This introduces a personal element which causes wheel waste. One operator will hold a



broken piece of wheel against the wheel face for a long time in order to make it cut freely, and thereby wastes a lot of the wheel.

(12) The use of incorrect grade of oil in the spindle bearings.—The space between the spindle and the bearings should be an amount just equal to the thickness of oil film, which is determined from the viscosity of the oil being used, whether it is a heavy or a light oil. If that clearance is set for a heavy oil and a light oil is used, then the spindle is not properly supported in its bearings, because this oil film should act as a supporting medium.

To increase the wheel service, use the automatic cross feed whenever possible. This also makes it possible to preserve sharp corners on the wheel and yet produce work rapidly. If the same amount of work is to be done with the hand feed the corners of this same wheel would probably be destroyed.

Support the work rigidly with plenty of solid non-yielding steadyrests, not springs on a rod held up against the work opposite the wheel, but a steadyrest

designed and studied with the idea of supporting the round work while revolving and holding it rigidly in all directions so that it cannot move under pressure.

See that the wheel is always well balanced. For the average wheel in use, standing balance is all that is necessary. Arbors and balancing ways are procurable for this purpose, and they are strongly recommended by good grinding machine engineers.

See that there are no heavy lacings or knots in the belts that drive the work or the wheel. Such foreign elements cause vibrations, and vibration in the grinding machine means wheel waste.

Use the diamond more frequently and lay the dresser aside. The diamond is really the only reliable means of truing a wheel. Dressers are convenient in rough grinding, but are usually wasteful of the wheel.

Study each operation and be sure that the very best condition of speeds, wheel grades, and equipment for handling the work are provided.

Grinding Thread Chasers

(A reprint from "Shop Information" in the Deane News, published by the Worthington Pump and Machinery Corporation, of Holyoke, Mass.)

The thread chaser may be likened to a tap turned inside out; a spring die chaser, so called because it is held in a holder which clamps or springs it from an oversize of eight to ten thousandths down to normal cutting size. Referring to figure 1, it is evident that the spring die chaser has the same elemental parts as a tap:

1. Lands or threading portion of the cutting edge or face.
2. Flutes or open space between teeth for clearance.
3. Chamfer or throat or starting end.

Throat Grinding

It is rarely necessary to grind a spring

[8]



FIGURE 1

[FEBRUARY, 1919]

die in the chamfer or throat, although it is sometimes necessary when a die has been abused. This method of grinding the throat is illustrated in figure 2. Use a small size cone-shaped wheel, one that will fit the curve of the throat of the die and apply lightly. All four lands must be

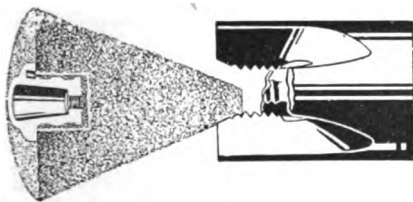


FIGURE 2

ground alike, as with a tap; otherwise the cutting is on one or two lands on which the least grinding is done. The throat should always present to the work a true and sharp cutting chamfer.

Cutting Edge or Face Grinding

To grind the cutting edge or face of a spring die, use a dish wheel, and apply it lightly to the cutting edge as shown in figure 1. When the die is new, the cutting edges are all ground parallel to those opposite and ahead of the center, as shown in figure 3—to make the die cut freely and to provide metal for future grinding. If the die is not abused, the cutting edges may be sharpened.

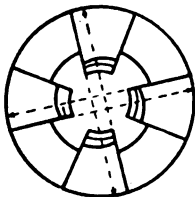


FIGURE 3

Figure 4 shows a die ground so unevenly that no two cutting edges are located with regard to the center. One cutting

[FEBRUARY, 1919]

edge is practically on the center, and the other three are all back of the center—a condition absolutely prohibiting successful thread cutting in steel. For satisfactory operation the opposite cutting edges must be parallel, as shown in figure 3.

Spring dies for cutting brass are made with the cutting edges radial from the center, as shown in figure 5, as a shearing cut is not required for this material. The

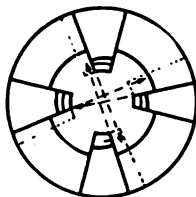


FIGURE 4

die will cut brass with the cutting edges ground back farther than the center. When it seems necessary to change the shape of the cutting edge to suit a particular kind of stock, the change must be made equally on all lands.

Threading cutting dies must be kept sharp and properly ground if good work

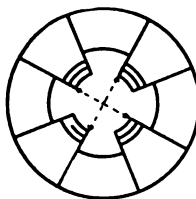


FIGURE 5

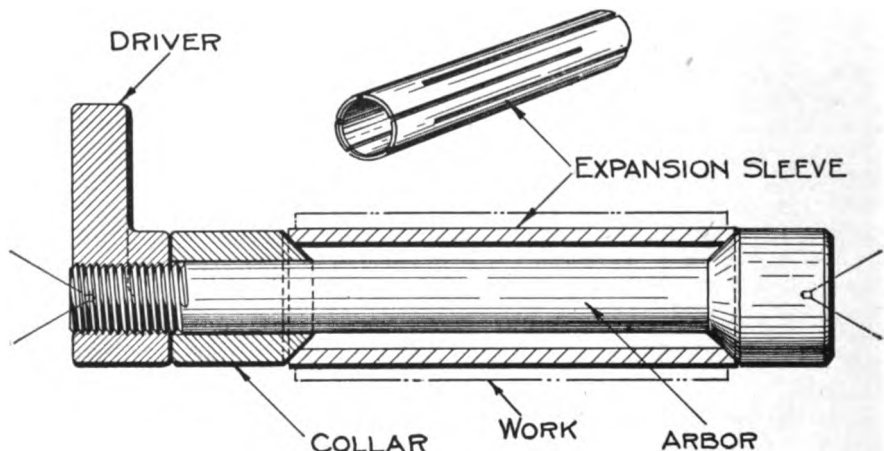
and long life is expected of them. Forging a die to cut after it has become dull results in rough, inaccurate threads and takes more power to drive. Grinding lightly, evenly on all four lands, and as frequently as the nature of the work requires is the surest way to get profitable service.



Grinding Kinks

By HOWARD W. DUNBAR

Fixture for Grinding Tubes



A fixture suitable for grinding tubes is illustrated above which provides an adjustable arbor actuated by a nut which forms the driving prong for the fixture when the part is assembled on it ready for grinding. An expanding sleeve split in such a manner as to expand uniformly on the inside of the tube locks it in place. It is very important that this expanding

sleeve be made accurate and properly tempered, so that it will spring uniformly and bind the tube to be ground to the arbor concentrically.

The nut for actuating this sleeve also forms the driving member, which makes it convenient to take on and off, the projection being used like a wrench.

Alundum wheels, grain 36 to 60 and grade K, L, and M are successfully grinding carbon steel punches. On this type of work the rather coarse and soft wheels give better results than the finer hard wheels. The hard wheel does not permit the cutting particles to break fast enough for the wheels to cut cool and free and when used on high speed alloy wheels a hard wheel will develop heat and burn the work.

Wheel Selection and Operation

(Notes from the Files of Sales Engineering Department.)

Speeding Up Production and Reducing Grinding Costs in the Foundry Cleaning Room

Where the product permits, time studies should be made so that piece rates and bonuses might be figured out and applied to foundry snagging. We have seen enough of this sort of thing to know that it usually pays.

Take the case of a medium size mid-western steel foundry that found itself hard pressed to get out its production of war work late in 1917. Their cleaning department was the key to their production and it was holding them back. More labor was not to be found and the delivery on new grinding machinery ran into months. They simply had to abandon the old day work basis of payment, figure out some kind of a piece rate that would be fair to the men, and on top of this add an incentive for extra production and economical use of grinding wheels. This extra incentive, the so-called bonus, is a very potent factor in reducing grinding costs where it can be intelligently applied.

At the start, they had fourteen men grinding on seven double-end floor stands. The labor cost per week for the fourteen men was \$231 under the day work system. When the special incentive system got into operation, four men could get out the tonnage of the fourteen. This reduced the labor cost per ton of castings cleaned 57 per cent. It also enabled them to get about three times the tonnage in a week they formerly secured and, of course, this solved their problem. Of course a softer grinding wheel had to be used to cut the labor costs down so low, but it certainly was worth while to pay a little more for abrasive in view of so remarkable an increase in output.

[FEBRUARY, 1919]

Have you a problem that might be solved by similar treatment? We are prepared to go into this with you at any time.

Comparison of Norton Grading Systems for Determining Hardness of Vitrified and Elastic Bonded Wheels

Many times, it is of great help to know what grade of wheel made by the elastic process will compare with a certain vitrified grade that has been in use until that time. This is especially true when for reason of desiring a smoother surface it is thought advisable to change over from vitrified to elastic bonded grinding wheels.

The following table will give our readers an approximate idea of the comparative value of our vitrified and elastic gradings. Although not exact, they are near enough for all practical purposes.

	Vit. Process	Elas. Process
Soft,	H	1
	I	1½
	J	2
	K	2½
Medium,	L	3
	M	4
	N	4
Medium Hard,	O	5
	P	5
	Q	6
Hard,	R	7
	S	7

If it is necessary to use organic bonded wheels harder than grade 7, then the rubber bond must be used. The Norton Company make their Alundum and Crystolon rubber bonded wheels in grade 8.

[11]



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

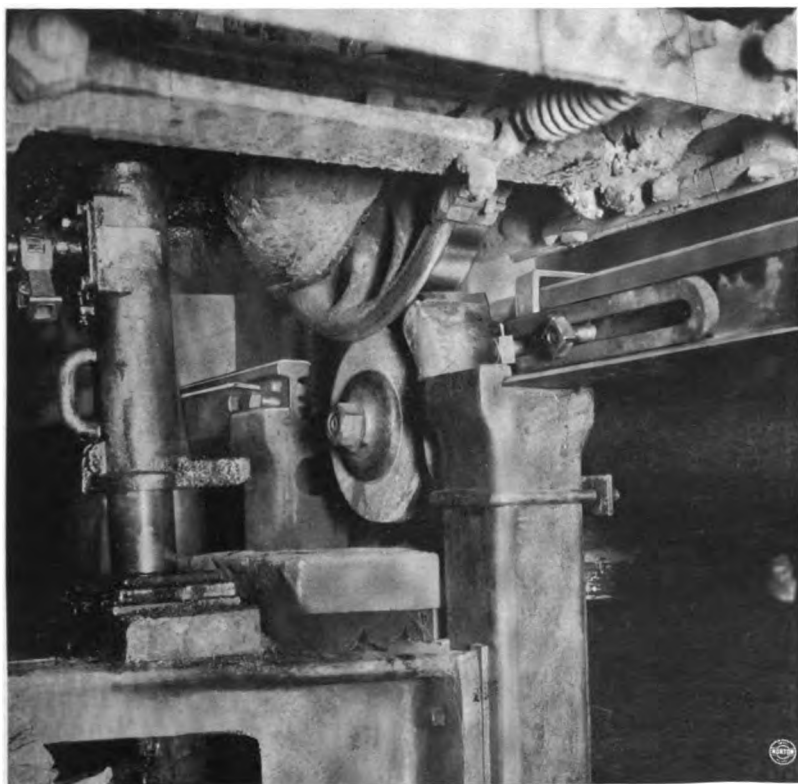
- Grinding Operating on "Caterpillar" Tractor Parts.** American Machinist, January 2, 1919, page 1. These grinding operations include the finishing of a great variety of gears, bushing, shafts, piston pins, and case covers. Details of the wheels and the limits of accuracy are given.
- Grinding Round Work without Centers.** American Machinist, January 2, 1919, page 4. This article describes a new grinding machine, built by the Detroit Tool Co., Detroit, Mich., which handles small rollers, bushings, and shafts as fast as they can be fed to it without the necessity for centering them, thus saving much time.
- Device for Gaging Cutters While Grinding.** American Machinist, January 2, 1919, page 31. "The sketch shows a device to be attached to a cutter-grinding machine for the purpose of grinding gear-tooth cutters correctly and for gaging and correcting such teeth as may be in error."
- Making Dies for Cutting Rubber, Leather, Paper, Cloth, etc.** American Machinist, January 9, 1919, page 52. Grinding is one of the steps in the process of manufacture of such dies.
- Stoning-up Cutting Tools.** American Machinist, European edition, December 28, 1918, page 94E. The writer claims longer life for cutting tools which have the cutting edge dressed with an abrasive stick after the operation on the grinding wheel.
- Aluminium Piston Grinding.** Alfred Herbert, Ltd., Monthly Review, December, 1918, page 8. This shop note tells what Norton wheels are used for this operation and how they are used.
- Harris Automatic Universal Hob and Form Cutter Grinding Machine.** American Machinist, January 23, 1919, page 180. Illustrated. By the Harris Engineering Co., 1047 Broad Street Bridgeport, Conn.
- The Question of Our Die Room Equipment.** American Drop Forger, January, 1919, page 26. About a quarter of the text deals with the grinding operation, and special shaped pencil grinders and special grinding wheels are illustrated.
- Heald No. 65 Cylinder Grinder.** Automotive Industries, January 23, 1919, page 222. Description of the new model made by the Heald Machine Co., Worcester, Mass.
- Hand Versus Power Feed in Surface Grinding.** American Machinist, January 30, 1919, page 218.
- Saphil Electric Grinding Machine.** American Machinist, January 30, 1919, page 227. A new portable electric tool, cutter, and surface grinding machine recently marketed by the Saphil Mfg. Corporation, 149 West Austin Avenue, Chicago, Ill.
- Connecticut Universal Grinding Machine.** American Machinist, January 30, 1919, page 229. By the Middlesex Machine Co., Inc., Middletown, Conn.
- Universal Lathe and Grinder Chart.** American Machinist, January 30, 1919, page 230. The writer gives a chart which may be used to find the number of revolutions per minute if the speed and diameter are known.

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GRI

GRITS and GRINDS

March

1919



**Grinding Flat Spots from Car Wheels Without Removing
Axle and Wheels from Truck**



Grits and Grinds

Vol. X

March, 1919

No. 11

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Information for Grinding Wheel Users

List of printed literature for free distribution by Norton Companies

Order by number and send your correct address

Catalogs

- (1) Norton Grinding Wheel Stands, Protection Hoods and Accessories
- (2) How to Sharpen and What to Use
- (3) Norton Products
- (4) Norton Refractories—Alundum Crystolon

Booklets and Circulars

- (6) Alundum and Crystolon Grinding Wheels
- (7) Alundum and Crystolon in the Cut Glass Industry
- (8) Bushing Grinding Wheels
- (9) Grain and Grade
- (10) Grinding of High Speed Steel
- (11) Grinding Wheel Dressers and Their Use
- (12) Grinding Wheels for the Saw Mill
- (13) Information Desired for the Proper Selection of Norton Grinding Wheels (special form)
- (14) Little Known Facts About Grinding

- (15) Norton Valve Grinding Compound
- (16) Polishing—What to Use—How to Use It
- (17) Saw Sharpening
- (18) Tool Grinding

Safety

- (19) Safety as Applied to Grinding Wheels
- (20) Safety Code for the Care and Use of Abrasive Wheels
- (21) Safety in Cutlery Grinding
- (22) Safety Rules for Machine Shop Employees

Miscellaneous

- (23) A Treatise on Dynamic Balance
- (24) Cam Grinding and Cam Grinding Equipment
- (26) Notice to Grinders (card for shop use)
- (27) Speed Charts—Surface Speed of Wheel and Surface Speed of Work
- (28) Standard Shapes of Abrasive Wheels

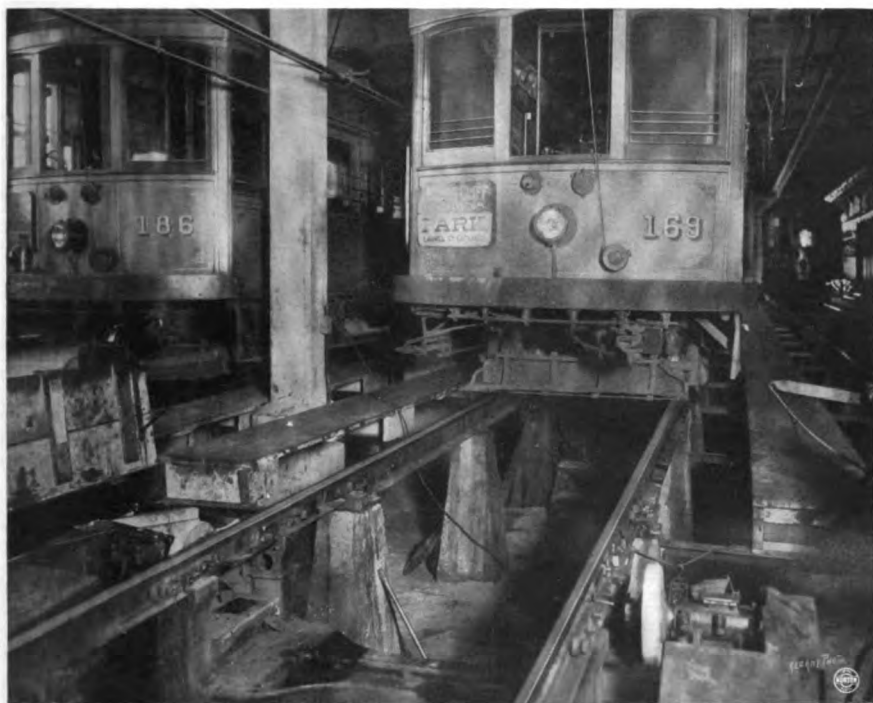
Grinding Chilled Iron Car Wheels

By S. J. BELL

Although machines have been especially designed for grinding car wheels mounted and unmounted, it is also desirable to eliminate flat spots due to continual usage without removal of the axle and wheels from the truck. This method has been satisfactorily carried out at the shop of the San Diego Electric Railway, San

on a heavy base, the whole being capable of a motion at right angles to the track, thus permitting the operator to readily place the wheel in position for grinding. The grinding head is also equipped with a vertical feed to compensate for wheel wear and diminished car wheel diameter.

The grinding wheel spindle is belt



Diego, Cal., by means of a Q. M. S. car wheel grinding machine sold by the Vulcan Engineering Sales Company, 2059 Elston Avenue, Chicago, Ill. The photographs on this page and cover illustrate the application of the machine to this work.

The pit grinder consists essentially of a grinding head with 2" diameter spindle running in a long bearing. This is mounted

driven by a motor bolted to the floor of the pit. This motor is also connected to a 110 volt generator which supplies the current for running the car motors at speeds below those obtained with the 500 to 600 volts usually furnished. This is necessary in order to insure the best results. This scheme entirely removes the 600 volt trolley circuit from use in connection with

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[3]



the grinder, thereby providing greater safety for the operator.

For grinding chilled iron car wheels on this particular machine, Crystolon wheels 14 x 2 x 2", grain 16 grade Q or R, have given very satisfactory results. The speed of the machine is 1,400 revolutions per minute while the car wheel revolves about 75 times per minute. The grinding is performed dry. The amount of material to be removed varies in each case, depending of course upon the length of the flat spot as measured along the tread. It has been found, however, that the average

time required to put a wheel in proper condition is 30 minutes.

In the photograph on page three both grinding wheels will be noticed withdrawn from the usual position when grinding and the scotching pieces or stops in place, which permit the car operator to center the wheels quickly. The stops are then removed on both sides of the track and the truck is supported by means of two jacks, one of which is shown in position. Due to the method of aligning the car wheels, all preparations necessary for grinding can be made in five minutes.

Grinding of Hardened Work

This subject of the grinding of hardened work is vitally important to all whose particular line is the grinding of steel. There has always been considerable trouble attendant upon this work, and it is due in many cases to other causes than the heat-treating of steel.

It is the universal experience of companies manufacturing products of strong general demand to find themselves held responsible for their particular products long after the customer has received them and put them to use.

In his address before the Steel Treating Research Society of Detroit, Mich., a short time ago, C. H. Norton of the Norton Grinding Company told some interesting experiences concerning the difficulties customers experienced in their grinding work of this nature, which the producers were able to solve by careful observation of the grinding conditions and the laying down of a few common-sense rules for the customer to follow.

The following are a few excerpts from his speech:

[4]

"A few years ago we had some customers who always seemed to be having some trouble with grinding. They could not grind their piston pins and have any temper left in them. They were sure that the grinding machine turned too fast or too slow, that the spindle was too large or too small, or that the grinding wheel was made of something it ought not to have been.

"Five years passed, and this was going on all the while. Finally it became quite serious, and as a result we sent along one of our own operators to do the grinding. He ground the piston pins with three different grades of wheels and did not draw the temper. A few days later a letter came from the customer saying that they had been convinced that the operator's method was all right, but that evidently it was not, since they were having their troubles repeated.

"The same operator was sent out again. This time he experimented. His game was to see how the customer went about grinding. And therein lay the cure of

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this five years of trouble. The particular grinding work was piecework, and the grinder thought that if he started lively, he would have more time to loaf later. He brought the wheel up too hard. This loaded the wheel with steel. It was not a grinding wheel at all; it was a steel wheel. It was a wheel that customer had spoiled.

"Another customer had trouble and could not grind cams. He sent some cam shafts to us to grind, and there was no temper in them. They were sent back with the directions to harden them before grinding.

"In the grinding of cam shafts that are hardened, it makes a great deal of difference whether the lifting side of the cam is a straight line and not a curve. The arc of contact is four times longer when grinding flat surfaces than when grinding a round piece two inches in diameter. There are some people grinding very rapidly, but the side of the cam is a curve. If they had a straight line there, the same people would probably fail in doing it. The side of the cam is the same as surface grinding, with an arc of contact practically four times as great as on cylindrical grinding. If you use wheels soft enough,

you can grind anything without drawing the temper. When we consider production, we have to feel our way and have a wheel that will stand a little longer, and use good judgment about when to stop. I do not believe that any two hardened pieces are just alike.

"With no two hardened cam shafts just alike, you will never be really successful if you revolve all of the cam shafts at the same speed. The difference in the cutting of the wheel must be studied, and that is where the art in grinding comes in and the construction of grinding wheels is a science, but the use of them is an art, and I doubt whether you will ever get beyond that; but there are certain fundamental things that are always science and will always work.

"To make your work come out without undue friction, it must be revolved at a speed that will keep the wheel from glazing, and also you must not force that wheel to a point where steel will adhere to it. That is about all there is to the whole problem of grinding hardened work. You can grind hardened work with any of three or four grades of wheels without drawing the temper, if you have any temper in there to begin with."

When reference is made to a hard wheel or a soft wheel, it is usually intended to convey the meaning that the wheel in question is hard or soft for the class of work under consideration. For example, grade L may be hard for grinding the bore of an automobile cylinder, although ordinarily it is considered a rather soft wheel, and an O grade, while classified as one of the medium hard grades in wheel manufacture, would be too soft for grinding malleable iron castings. Such references to hard and soft wheels are frequently misunderstood.



Little Known Facts About Grinding

Depth of Cut

BY HOWARD W. DUNBAR

In commercial cylindrical grinding the depth of cut, that is, the amount of feed of the grinding wheel into the work per revolution of the work, is an important factor in determining the grade and grain of the wheel, which in turn is a factor in determining the rate of production of the parts being ground. This, of course, is relative to the width of the face of the wheel being used and the power available at the machine.

Although there are some classes of work that are only produced rapidly by deep cuts it is safe to assume that in most cases the greatest production is obtained when using the maximum width of wheel face that a given machine will carry, at the same time using the maximum traverse of the work so that the face of the wheel will cover the work being ground with the largest number of cutting particles per minute.

To illustrate this point it is wise to draw a comparison between the grinding of steel and chilled iron. For example: the most economical way of grinding soft steel is with a relatively deep cut and a soft wheel, whereas in order to produce an equal amount of work in grinding chilled iron casting it would be necessary to take a lighter cut and cover a greater amount of the material being ground with a wider wheel, thereby removing an equal amount of material in the same time. The reason for this is that the wheel will not stand the deep cuts in chilled iron. It naturally follows then that the greater the number of cutting particles coming in contact with the work in a given time, the less depth of cut is necessary for a given amount of material removed.

In speaking of the width of face of wheels in use it might be interesting to mention that on certain operations wheels as wide as 6" and 7" are commonly used, and in some special cases wheels as wide as 10" have been used. To get the best results and the largest quantity of work when using these wide wheels the work should be traversed the entire width of the face of the wheel at each revolution of the work. This, of course, only relates to that kind of work which has to be stroked while grinding. In work which is accomplished by the straight-in cut the width of the face of the wheel must be slightly wider than the surface being ground.

As the wheel wears down, the surface speed of such a wheel is naturally lessened, so that the grain depth of cut will have to be increased because of this lessened wheel speed, and also because of the smaller diameter of the wheel, which results in a smaller arc of contact of the wheel with the work. Similarly, it is true that as the work diameter is increased larger chips will be cut from the work, and since the cubic inches of material being removed will remain constant for a given length of time the thickness of these chips, or the grain depth of cut, must be lessened. These statements are all assumed that in each analysis other factors remain constant—that is, the wheel speeds, work speeds, etc. Accordingly, a wheel should appear harder as the diameter of the work increases, or softer as it decreases; a wheel should appear softer as the wheel diameter decreases and harder as it increases. These facts have led to the following conclusions which I quote from Professor Alden's theory of grain depth of cut:

"(a) Other factors remaining constant, increase of work speed increases grain depth of cut, and makes a wheel appear softer.

"(b) Similarly, a decrease of wheel speed increases grain depth of cut.

"(c) Similarly, diminishing the diameter of the grinding wheel increases grain

depth of cut, and increasing the diameter of the wheel decreases grain depth of cut.

"(d) Similarly, making the diameter of work smaller increases grain depth of cut. Conversely, making the diameter of work larger makes grain depth of cut smaller."

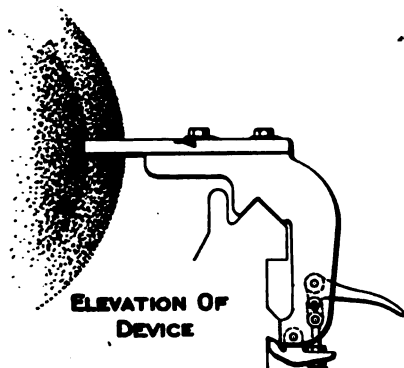
Grinding Kinks

Special Truing Device for V Face Wheels

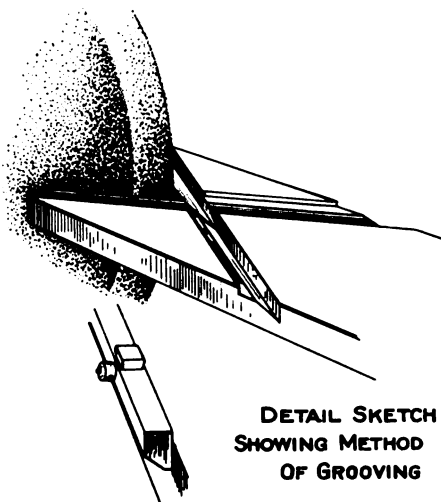
BY HOWARD W. DUNBAR



PLAN OF DEVICE



ELEVATION OF
DEVICE



DETAIL SKETCH
SHOWING METHOD
OF GROOVING

DETAIL SKETCH
OF SLIDING
MEMBER

We are frequently confronted with a need for a special truing arrangement for truing the face of the wheel to some special shape, and the V type of wheel face is one which is used a great deal on certain grinding operations, particularly in the tool room. So we are illustrating here a little fixture we have seen in operation which, in the hands of a careful operator, yields very good results.

The diamond is simply mounted in the slide which when placed in the grooves on the master plate can be

guided across the face of the wheel and trued up to any desired angle, merely by having different plates with different angles in them. A convenient way for mounting this master plate is to take an old steadyrest body which has been worn out and machine it off to permit the plate to be mounted on the top, thereby leaving a bracket to clamp on the table of the Norton machine in the regular manner. The illustration is clear enough to need no further explanation.



Notes from the Files of Sales Engineering Department

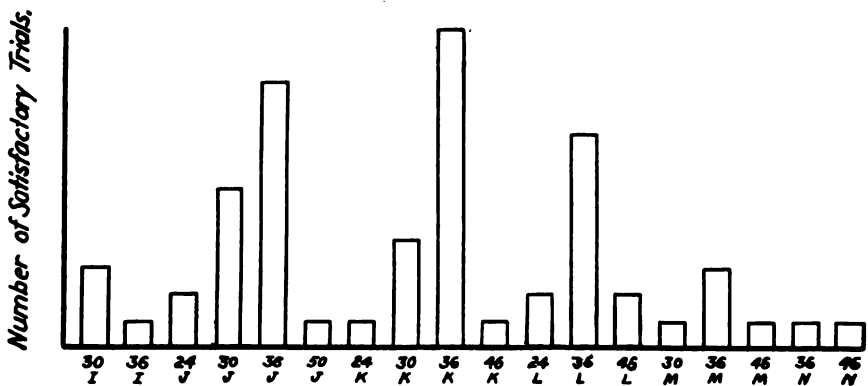
Piston Grinding

The importance of this particular operation cannot be overestimated when it is considered that 1,500,000 automobiles are to be manufactured during the present year. Adding to this the large number of tractor, marine, and stationary gas and gasoline engines to be made, we believe a conservative estimate of the number of cast iron pistons to be ground is 6,000,000. Crystolon, the Norton silicon carbide abrasive, will, we hope, be called upon to do a large amount of this work.

Many factors affect the action of a wheel on this work: kind of iron, speed of traverse, surface speed of work, size of pistons, amount of material to be removed,

the satisfactory trials which have been conducted with the different grains and grades of Crystolon wheels. Each column is built up of units, each unit representing one satisfactory trial of each particular grain and grade. The chart shows clearly the wheels that are most often recommended and successfully used, namely, grain 36 grades J, K, and L Crystolon vitrified.

The results were not obtained by making an equal number of trials of each type of wheel. It cannot be said therefore that a 36-J wheel will be successful twice as often as a 30-J, even though the block on the chart representing the former is twice



Grain and Grade.

the way the wheel is dressed, the amount of grinding lubricant used, rigidity of the machine, and the operator himself. The last mentioned factor is all important. One operator will use a soft wheel, whereas the man next to him may use a harder wheel with equally good results as regards cutting action and production.

This chart is a graphic compilation of [8]

as high as that of the latter. The chart does indicate the trend of our recommendations; and unless some local condition influences our selection of wheels, our first choice would be a 36 grade K, second 36-J, and third 36-L, all of course Crystolon and made by the vitrified process.

So that you may have this information at hand when you wish to choose a Norton

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trial wheel for piston grinding, we shall be pleased to send you a copy of the chart printed on a sheet of convenient size.

As a guide to you in determining whether your production is up to what is being obtained in other shops, the figures below may prove interesting. They are obtained from customers' reports of trials and in one case from one of our own demonstrators' tests and were in each case obtained with Crystolon wheels.

More difficulty is encountered in grinding pistons made of aluminum or aluminum alloys. Unless care is exercised this material tears when being ground the same as when it is machined with a steel tool. It is also easily scratched.

Grain 40 grade J Crystolon and 24 com-

bination grade K Alundum vitrified wheels are being successfully used.

The grinding lubricant used has a marked effect on the results accomplished. Aqualene, kerosene, and a mixture of kerosene and lard oil are giving very satisfactory results. Owing to the tendency of aluminum to scratch, the grinding solution must be changed frequently. A fine mesh wire or cloth screen placed over the tank end of the water pipe will keep the chips in the tank and allow the solution to be used longer than would otherwise be possible.

A very good finish can be obtained by rubbing a piece of beeswax or paraffine over the face of the wheel before the finishing cut is made.

If you have any particular questions you think we would be able to help you out on, kindly send them in to us.

Wheel Size	Grain and Grade	Piston Dimensions	Per Dressing	Pistons Ground Per 10-hr. Day	Per Life of Wheel 10,000
18 x 2½ x 8"	36		80		
18 x 2 x 8"	46-L	4⅞ x 4"	45		
24 x 2 x 5"	36-K	4 x 4"		230	
14 x 2 x 5"	24-K	3⅞ x 4½"		270	
14 x 2 x 5"	24-K	4 x 4¼"		250	
14 x 2 x 5"	24-K	3 x 3½"		285	

Storage, Handling, and Supervision of Abrasive Wheels

By P. A. BRIDGMAN

Unpacking Wheels

Wheels leave Norton Company packed in a way which should safeguard the package against the roughest sort of treatment in transit. When unpacking these wheels a reasonable amount of care should be used, and if the unusual has happened and there is breakage it should be reported at once. After unpacking wheels, and before placing them in stock, they should be examined to see that grain, grade, and other specifications correspond with the original order.

Tapping Test

If after tapping wheels with a wooden mallet no satisfactory clear ring is produced, it is well to be on the safe side and reject the wheel. This test, however,

should be made when the wheels are perfectly dry and quite free from sawdust.

Wheel Racks

Wheel racks should be so constructed that once the wheels are on the shelves there will be no chance of their rolling off as the result of some unusual vibration. This can be accomplished by making these shelves of parallel beams 3" or 4" apart; or if there are already flat shelves, by fastening wooden strips in such a way that the wheels cannot roll off.

Storing Elastic Wheels

Elastic wheels ½" thick and thinner should be placed on a shelf with a plane surface. Norton Company uses a block of slate under each pile to prevent warpage.



Trucking Large Wheels

In carrying wheels 20" to 28" diameter grain 60 and finer it is best to use a transfer platform, placing the wheels flat on their sides with boards between them. Wheels larger than 28", both for convenience of handling and prevention of breakage, should be carried on trucks which will retain them in a vertical position.

Stacking "Shape Wheels"

Saucer, cup or even straight wheels which are not over 6" in diameter and made by either the silicate or vitrified process should be stored flatwise in stacks or on edge, whichever is the more convenient. If, however, there is a thin edge on the wheels, it is advisable to stack these flat, particularly wheels of the softer grades. Cup wheels over 6" in diameter and all cylinder wheels should be piled flatwise. Tapered cup wheels should, of course, be piled carefully, with the back side up. It is desirable to have all silicate and elastic wheels stored in a dry place.

All rubber wheels over $\frac{3}{8}$ " thick should be stacked on their edges.

Wheels 2" or less in diameter are best cared for by placing them in boxes or drawers with the grain and grade plainly labelled on the outside.

When removing abrasive wheels from storage remember that they must at all times be handled carefully.

Mounting Wheels on Machines

A few general rules are necessary to observe before the wheels are put on the machines. In the first place look carefully and see that there are no cracks and that the structure is in no way impaired. In the case of large wheels tap them again and listen for that clear ring which indicates a sound wheel. Be sure that the wheels fit the spindles freely. If necessary, the hole should be scraped out until the wheel will slide on to the spindle without being forced.

Diameter of flanges should be at least one-third the diameter of the wheel, preferably one-half.

The nut holding the flange should be tightened only enough to hold the wheel properly.

[10]

If there is any tendency on the part of the wheel and nut to turn, the spindle should be so threaded that in this event the action will tighten the nut.

Give the operator a chart showing him at what speed certain wheels should be used and instructing him not to use a greater speed; or show maximum and minimum speeds allowable.

Supervision of Wheel Stock

Unnecessarily heavy overhead charges may sometimes be caused by a haphazard method of supervising wheel stock.

Even a comparatively small stock should be carefully looked over, weeded out, and tagged. Failure to have a large stock of wheels properly indexed may prove a distinct economic waste.

Supervision of wheel stock calls for the services of the most expert grinding man you have in your plant. In order that these remarks may be constructive we present one method of keeping wheel stock, which is in favor at the factory of one of the large automobile manufacturers.

In a great many factories the upkeep of grinding wheel stock is in charge of the small tool or tool stock foreman. As a usual thing, the requisition for wheels originates with the various departmental foremen.

In the case of the large automobile manufacturer, however, the orders for grinding wheels usually pass through the hands of the foreman of the main Grinding department. In the first place accurate records were installed and a perpetual inventory, with carefully determined, but properly flexible, maximum and minimum limits, was set.

These limits or requirements are based upon the average consumption over a six months' period so that the average stock of grinding wheels will be sufficient to meet the demand for this period.

Perpetual Inventory

One of the clerks for this foreman makes out requisitions which are countersigned by the foreman and forwarded to the Purchasing department. When the purchase

[MARCH, 1919]



order is made out a card attached to the requisition is returned to the grinding room clerk, who makes proper notation on the inventory card. It is quite possible that there might have to be certain exceptions made in other factories as there is in this one. For example, the foundry turns in direct requisitions for a few varieties of wheels which they use. The reason for this is on account of the difficulties of transfer of large wheels and, in this particular instance, the distance from the main plant.

Expert Supervisor

One of the greatest advantages of having a man with expert knowledge of grinding in charge of wheel supervision is the fact that there naturally results a diminution of the variety of wheels carried in stock without lessening the production of the grinding machines.

By expert supervision of this sort it seldom happens that there are not at all times wheels available for any job. Also, from the standpoint of the wheel manufacturer, this is particularly desirable as customers often send in rush orders for wheels which are not standard and require perhaps an undesirably long time for manufacture.

When there is such careful supervision as this all chances are eliminated for requisitions coming to the purchasing agent from various departmental foremen for wheels which differ but slightly in grain, grade, and size due to diversity of personal opinions, prejudices or merely because of ignorance of the possibility of uniting upon a standard wheel for several purposes.

There is another direct result of expert supervision such as this. Foremen of other departments who have limited grinding experience soon see the advisability of consulting the man who is devoting his

entire time to grinding and they are quickly convinced that his advice usually means increased production and freedom from wheel trouble.

The man of special experience is constantly schooling himself to overcome wheel problems that are caused by changes in character of the metals being ground.

He is able to advise whether a change in wheel or work speed will solve the problem or whether it requires a selection of a wheel of different character. Making a specialty of this study, he can become a distinct factor and play an important and helpful part in the production program.

There is, aside from the direct advantage to the factory, a part this man plays which will be of interest to the Cost department. He can overcome by this system the tying-up of capital in wheel stock caused by the placing of orders on a foreman's requisition. It is quite easy and very natural for each foreman to enter his requisition for a certain number of wheels. At the same time, however, two or three other foremen may be entering orders at the same time for the same grain and grade of wheels. In this way the firm may possibly purchase in round numbers 150 wheels, when by supervision it would have been unnecessary to purchase more than 50 to keep all departments supplied.

Finally, it is well and absolutely necessary to bear in mind that in these days of constant changes in design and material necessitating distinct changes in wheel requirements, it is not impossible for a wheel which is standard to-day to become "dead stock" within a few weeks' time. Users of grinding wheels by adapting this system to their own peculiar needs will find that their stock of wheels will be much better selected, more available, better indexed and furthermore the necessity for placing rush orders or using improper wheels will be practically eliminated.



Abstracts from Current Articles Pertaining to Grinding

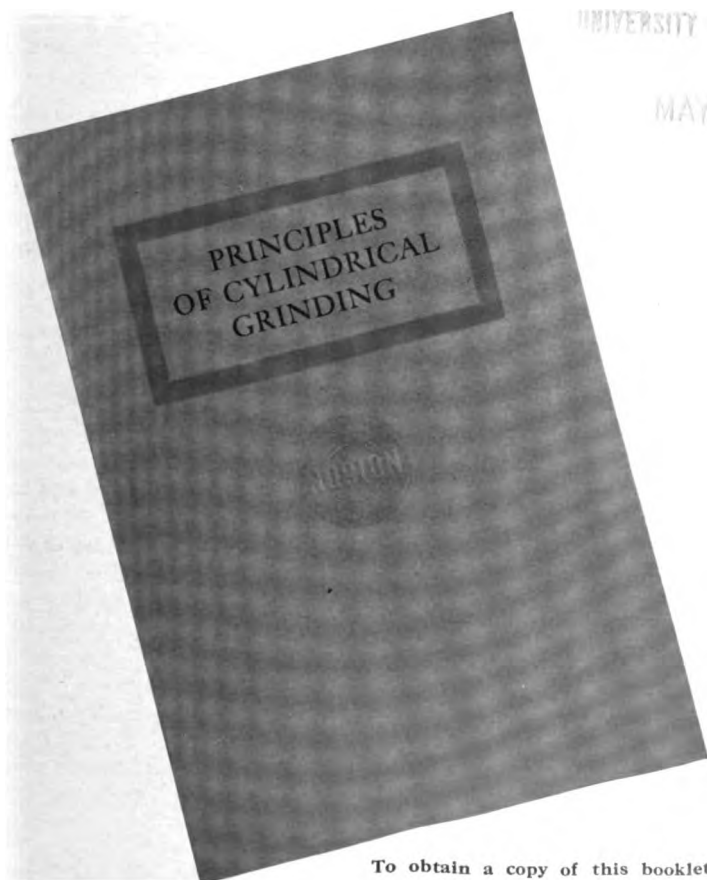
Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

- Manufacturing the Caterpillar Tractor. American Machinist, February 13, 1919, page 299. The grinding of cylinders, pistons, pins, and crankshafts is described in this article.
- Turning Band Wheels. Woodworker, February, 1919, page 39. The writer prefers a stone or block made of some abrasive material for this operation instead of a machinist's tool. He explains the difference in meaning of the terms "stone" and "wheel" and describes the use of a stone for this kind of work.
- Passing of Hand-Filing. Woodworker, February, 1919, page 41. Some of the advantages of sharpening saws on grinding machines are mentioned briefly in this article.
- Hand Versus Power Feed in Surface Grinding. American Machinist, February 20, 1919, page 356. The writer emphasizes the advantages of hand feed in support of a previous article by Mr. Donald Baker.
- Sharpening Slitters on a Cutter Grinder. Canadian Machinery, February 20, 1919, page 188.
- Grinding of Hardened Work. American Drop Forger, February, 1919, page 106. A paper by C. H. Norton presented before the Steel Treating Research Society in which he discusses some of the difficulties encountered in such work.
- Mandrel for Grinding Wristpins. American Machinist, February 6, 1919, page 259. The drawing shows a quick-change mandrel for holding automobile wristpins for grinding.
- Grinding Taper Reamers in a Small Shop. American Machinist, February 6, 1919, page 259.
- Black & Decker Electric Valve-Grinding Machine. American Machinist, February 27, 1919, page 416. A motor-driven, poppet-valve grinding machine manufactured by the Black & Decker Mfg. Co., South Calvert Street, Baltimore, Md.
- Springfield Heavy-Duty Oscillating Surface-Grinding Machine. American Machinist, February 27, 1919, page 416. A surface-grinding machine marketed by the Springfield Mfg. Co., Bridgeport, Conn.
- International Thread-Gage Grinding Machine. American Machinist, February 27, 1919, page 418. A detailed account of a grinding fixture for finishing thread gages, which has been developed by the International Thread Gage Co., 100 West 23d Street, New York, N. Y.
- Cylinder Grinding. Machinery, March, 1919, page 615. This article tells the advantages of finishing cylinder bores by grinding, describes the machines and auxiliary equipment used, and relates the practice in different plants manufacturing engines for automobiles and airplanes.
- Blanchard No. 10 Surface Grinding Machine. Machinery, March, 1919, page 659. This machine is especially adapted for use in plants where it is necessary to grind pieces less than 18 inches in diameter, one at a time, or where small tools have to be ground in limited quantities.
- Graduated Precision Grinding Attachment. Machinery, March, 1919, page 660. Made by the Precision & Thread Grinder Mfg. Co., 1932 Arch Street, Philadelphia, Pa. It is adapted for use on lathes, milling machines, and other types of machine tools, and can be employed for the performance of a great variety of grinding operations.
- Westinghouse Polishing and Grinding Motors. Machinery, March, 1919, page 664. One of the recent products of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is an electric motor with the armature spindle extended to provide for mounting grinding and buffing wheels at opposite ends.
- Petterson Drill and Valve Grinder. Machinery, March, 1919, page 669. A combination drill and valve grinder is being made by the Petterson Engineering & Mfg. Co., 311 Main Street, Worcester, Mass. It is stated that less than a minute is required to change the tool from a drill to a valve grinder, or vice versa, and a screw-driver is the only tool required to make the change.

GRITS and GRINDS

April

1919



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without charge, write to
Norton Grinding Co., Worcester, Mass.



Grits and Grinds

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Selection of Wheels for Thread Gauge Grinding

Results from a number of extended tests in different sections under different conditions establish the following grains and grades as most generally successful for the work as listed:

U. S. STANDARD AND "V" THREADS

(Plug Gauges)

9 pitch and coarser	100-0	Alundum
	120-0	"
	150-J to O	"
9 to 16 pitch	120 K, L, M	Alundum
	150 K, L, M	"
	200 K, L, M	"
16 to 24 pitch	150 N	Alundum
	180 N	"
	200 M	"
Finer than 24 pitch	180 N, O	Alundum
	200 M, N, O	"
	150 P	Crystolon
	180 N	"
	200 M	"

(Ring Gauges)

16 pitch and coarser	100 O	Alundum
	120 N, O	"
	150 N	"
Finer than 16 pitch	150 N	Alundum
	180 N	"
	200 N, O	"

WHITWORTH STANDARD

Roughing—100 J, K, L, M Alundum.

Finishing { 38120 to 38200 J and K Alundum
38200 to 383F grades I and J "

It is a common practice to relieve the bottoms of the threads slightly. This relief, which is nothing more or less than a groove at the base of each thread, also makes it easier for the grinding wheel to maintain its shape for a satisfactory period. Occasionally, however, there is so much stock left on the gauge before hardening that when it has been finish-ground, the relief is entirely ground out. It then becomes necessary to grind another one into the bottom of the threads so that the gauge will conform to the inspector's requirements. The face of the grinding wheel must be very accurately dressed to almost a knife edge in order to grind this relief successfully. A groove about 0.003" in depth is usually sufficient.

Wheels 200-N and O have been found satisfactory for this operation.

The external grinding should be done wet, using either soda water or a grinding solution. It has been found in some plants that the soda water is better for this work, because it does not obscure the plug gauge while the grinding is going on.

Wheels bonded by the silicate process should not be used for thread gauge grinding. Elastic process wheels may occasionally be found satisfactory, but only for finish grinding after a vitrified wheel has been used for roughing. The most suitable bond for this operation is the vitrified and it is recommended that this always be used.

In conclusion we might summarize the factors most important in influencing grinding wheel selection for thread gauge work.

1. Type of Grinding Machine.
2. Weight and Rigidity of Machine.

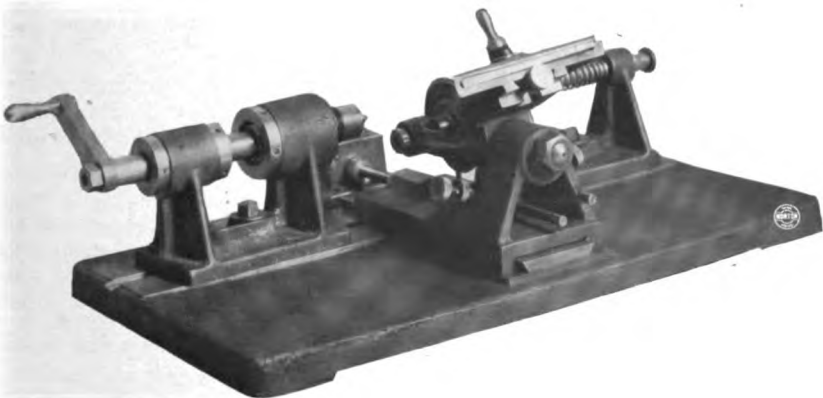
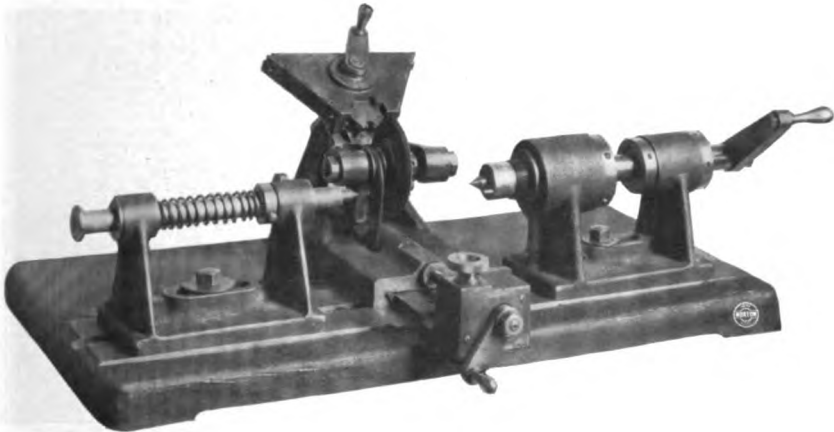
3. Truing Device must be firm and smooth acting.

4. Type of Thread (V, U. S., or Whitworth).

5. Pitch of Thread.

6. Personal Factor.

Although remarkable progress has been made in this field, there is no evidence that the conclusions reached so far will be established as final. Experiments are still being carried on and further developments may be looked for. We would welcome the opportunity of co-operating with any firms who are interested in an investigation of the proper wheels for the various gauges.



**Two Views of a Special Machine for Thread Gauge Grinding in Use
by the Ordnance Tool & Manufacturing Company, St. Louis, Mo.**



Little Known Facts About Grinding

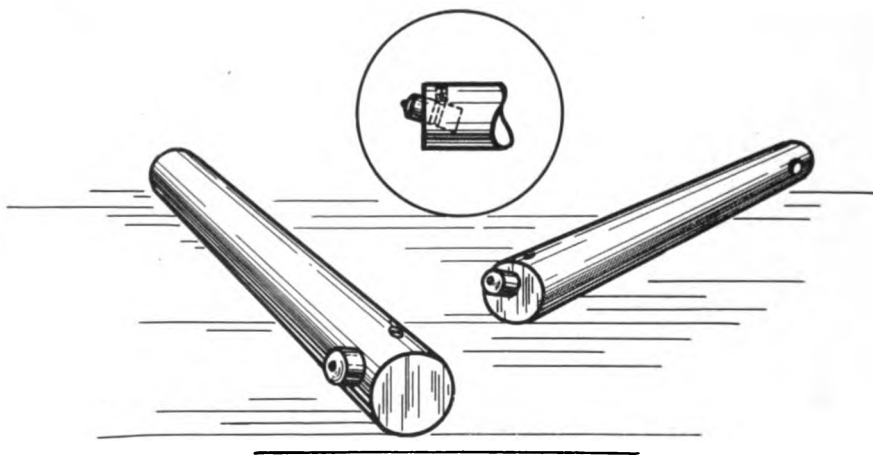
By HOWARD W. DUNBAR

Diamond Nibs and Holders

In connection with the truing of a grinding wheel when a diamond is used it is important and necessary that the holder, the nib, and the diamond be properly mounted and held in a manner which will insure the diamond remaining in a fixed position during the truing operation. It is not the purpose of this article to treat on diamonds or diamond mountings, but merely to indicate some of the methods employed and reasons for certain conditions in diamond holders, mountings, and their use.

have been recommended to discover this looseness, but this one seems to be the nearest to fool-proof.

The accompanying illustration shows the method of mounting the diamond nib in the holders. As a matter of interest it might be mentioned that the diamond nib is always placed in the holder when used on the end for truing the face of the wheel at a slight angle. This angle is there for the purpose of making it possible to present a new cutting edge on the diamond to the wheel as it wears, in order to dis-



A good test to determine whether the diamond is rigidly fixed in its mounting has been suggested by one of our grinding machine experts. He says that by hitting the diamond holder, or shank as it is called in the grinding department, against some hard material, like the footstock body, a clear ring resulting will indicate a solid setting. If it does not ring clearly or has a cracked sound, one can be sure that some part of the mounting is not solid. Sometimes the set screw is loose; sometimes the diamond itself is loose. A great many tests

tribute the wear on the diamond over its entire broad surface. It can readily be seen that by loosening the nib and turning it around to a new position this point can be accomplished.

The nibs are also provided with holes drilled at right angles to the length of the bar, so that the nib can be put in in this manner for dressing off the side of the wheel. This is very necessary in cases where you grind down into a shoulder, as in crankshaft grinding.

Loose diamonds or loose nibs can also be detected sometimes by putting a screw driver against the diamond shank, while the diamond is truing the wheel, and putting the handle of the screw driver to one's ear. If it is loose, it is apt to vibrate and it can be heard in this manner.

Great care should be taken with the use

of diamonds in this particular respect, as any looseness will cause vibrations and irregular truing which will, in turn, produce unsatisfactory results. Even the holder on the footstock into which the diamond is fastened must be rigid and the set-screw must be brought down tightly against the diamond shank.

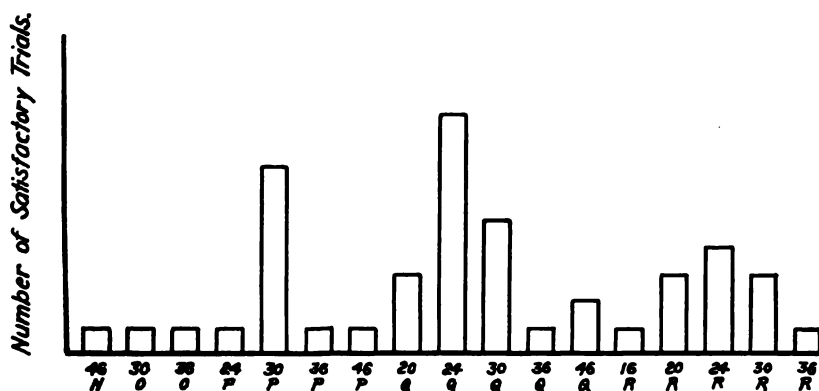
Notes from the Files of Sales Engineering Department

Crystolon Wheels for Snagging Brass and Bronze Castings

The physical properties of brasses and bronzes vary as do those of steel. An understanding of the effect of different metals on these properties is of interest and importance to those who are called upon to recommend grinding wheels for snagging castings made of brass or bronze.

remaining the same the higher tensile strength will call for a harder wheel on snagging operations with sharp contacts and perhaps a softer wheel on snagging, broad contact, and on precision grinding.

Adding lead up to 3% makes a softer, weaker material which will be more apt



Grain and Grade.

Brass is an alloy of copper and zinc in varying proportions from 40 to 90% copper and for special uses other metals are added in small amounts. The tensile strength of copper is 26,000 pounds. This tensile strength is increased to 45,000 by the addition of 30% of zinc to the copper. As the alloy is changed to 50% of each, the tensile strength drops to 1,000 pounds. Since tensile strength is the property that resists the removal of material, a change in this property will of course affect the grade of the wheel necessary. With other factors

to load a wheel and call for a structure that will break down more readily. A treated wheel should be tried on this material, if untreated wheels do not prove satisfactory. The filling used in a treated wheel becomes fluid during grinding and lubricates the cutting grain at exactly the point of contact.

Tin and manganese give a harder brass and may make the use of a harder wheel advisable for sharp contact and a softer wheel for broad contact.



Iron to the extent of 1 to 2% increases the tensile strength to 80,000 pounds and gives an iron that produces a very sound, uniform casting. Owing to this high tensile strength an Alundum wheel may be found more efficient than Crystolon, as the latter, being brittle, may break down too fast to give best results.

Bronze is very similar to brass. Phosphorus, aluminum, and manganese with copper produce bronzes that have a high tensile strength, higher in some cases than 20 point carbon open hearth steel. This may also be an Alundum proposition.

The chart above shows the results of a large number of trial wheels used for snagging brass and bronze castings. You

will notice that a fairly large number of different grains and grades have been successfully used. This large variation is due to kind of material, condition of machines, speed of wheels, operator, size of castings, condition of castings as they come from the foundry, and many other factors.

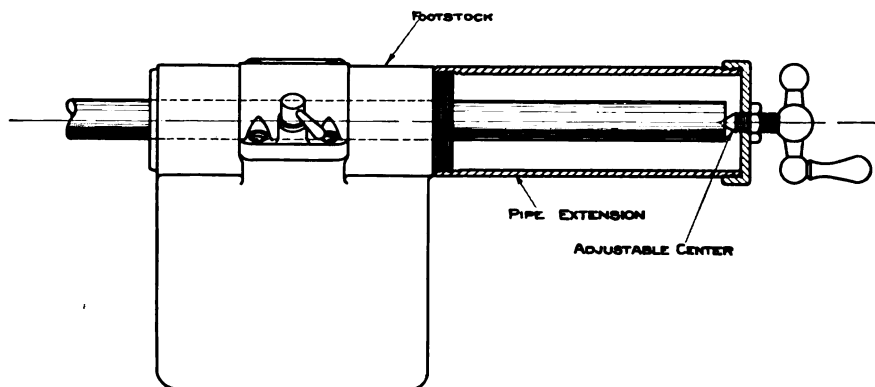
You will notice that 24 grade Q and 30 grade P Crystolon wheels are more often tried and more often successful than the others. We would recommend these two wheels for trial first, unless some local conditions made the trial of some harder or softer wheel advisable.

If you wish one of these charts for your files, please let us know and we shall be pleased to send one to you.

Grinding Kinks

By HOWARD W. DUNBAR

Imvised Footstock for Handling Work Too Long for the Machine



We are illustrating in this issue a means for extending the capacity in length of a machine on jobs where it becomes necessary to produce a long piece of work when one has not a machine long enough to handle this work. We wish to emphasize the point that we do not recommend this as a practice to be followed continuously, but occasionally one is up against a single job to be done with only a short machine in which to do it. Here is a simple and in-

expensive means of accomplishing results in such cases.

A piece of ordinary pipe can be fitted to the threaded end of the footstock body after having first removed the footstock spindle and cap. The end of this pipe can be covered with a cap and a center with an adjusting screw supported in this cap, similar to the illustration. By grinding the full capacity in length of the machine the work can be reduced to the proper diameter. Then by removing it from the

machine and turning it end for end it is possible, by the use of the proper number of steadyrests, to match the work on at the point where the grinding left off, and finish-grind the unground portion of the

shaft. Too much emphasis cannot be placed on the necessity for a large number of steadyrests, as the success in matching on the two grinding portions depends largely upon their use.

Commercializing the Sparks

By P. A. BRIDGMAN

Mr. S. S. Buckley, president of the Onondaga Steel Company at Syracuse, N. Y., according to an article "Reclaiming High Speed Steel Scrap" in the March edition of *Iron Age*, has commercialized the grinding man's old stunt of "watching the sparks." As a general thing this has been done to note the depth of grain cut, many an expert being able to approximate to the fraction of a thousandth the amount of material being removed.

Mr. Buckley's business is reclaiming high speed steel scrap which before the establishment of this enterprise had been wasted up to about 40% of all the expensive high speed steel sold. The initial proceeding which interests us particularly is the use of a special composition grinding wheel to determine from the sparks the carbon content of the scrap metal sent to his factory for reclamation.

Each piece is given the grinding test and it is claimed that the workmen can read the story of the steel's composition in the sparks thrown from the wheel at least sufficiently to properly distribute the different grades.

The Onondaga Company's methods of sorting the steel, crucible treatment, rolling and snagging of the billets we will not undertake to explain but the point we have already touched upon brings to mind an article in "Grits and Grinds" for February 1913 on "Grinding Wheel Sparks."

This is descriptive of the significance of sparks and in order that the gist of this article may be of more worth to the reader a reprint is made of the chart prepared by Mr. Jno. F. Keller, instructor in forging and heat treatment of metals, Purdue

University. Before reviewing this chart it will be well to generalize to some extent on sparks. Sparks are pieces of metal which are torn away from the mass being ground and during this tearing away process are heated to such a high temperature that they become molten. In this state they give out light, the amount of light produced being proportional to the temperature to which the metal is heated.

It would be reasonable to expect that the sparks would first appear as small solid globules since it is the law of surface tension that liquid when thrown through the air takes on spherical form. As a matter of fact, when the sparks first cool they do take on this form, but on becoming colder the outside and solid shell contracts on the liquid interior until pressure is sufficient to break the outside shell and the phenomenon which takes place is referred to as spurting or forking.

The first time that the significance of sparks from the grinding wheel was particularly noticed was with the advent of high speed steel. It was seen that this steel did not spurt in the same manner or with the same general characteristics as that of ordinary carbon steel. This naturally led to a certain curiosity in regard to the reason for the different spark characteristics. On investigation it was found that the combination of the oxygen of the air with certain constituents of the metal being ground (which are not high temperatures) produced sparks of a certain appearance, the type of spark being dependent upon the proportions of these constituents present.

In other words a high carbon steel gives a large volume of sparks, a low carbon steel giving a low volume. High speed steel,



SPARK METHOD
— OF —
SELECTING IRON AND STEELS

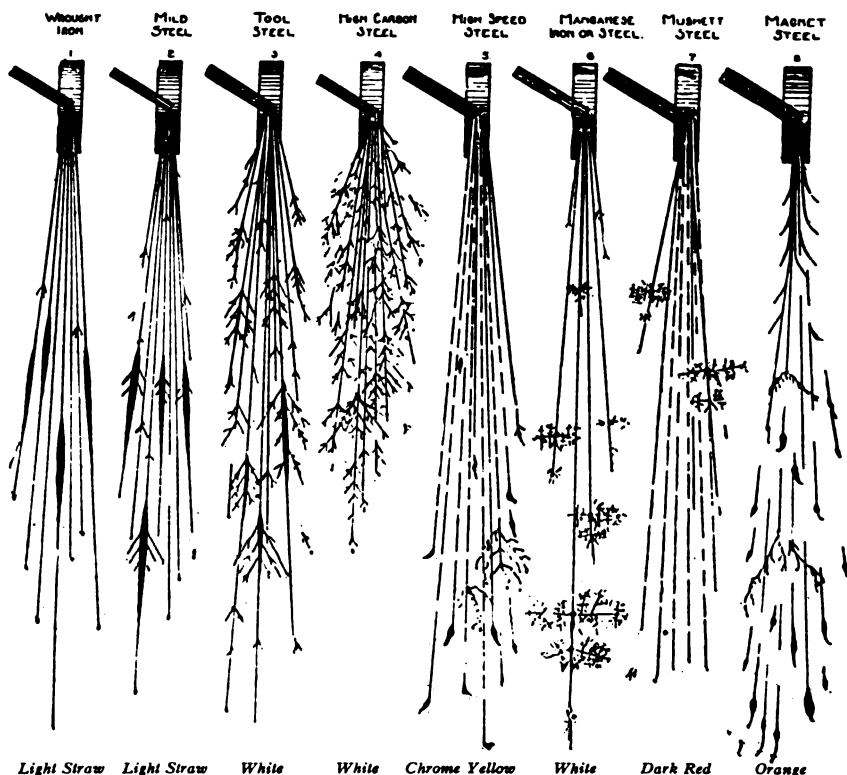


Chart Prepared by Jno. F. Keller to Show Spark Characteristics
Copyrighted, 1911, by Jno. F. Keller

however, is in a class by itself. The drawing which is shown here, although not strictly accurate, may nevertheless be found of some use as an aid in determining metals being ground. Let us take for example figure 1. Wrought iron is practically free from carbon and the sparks follow straight lines which become broader and more luminous until they reach their maximum size and gradually diminish until they grow dark. Practically none of the sparks explode or "spurt," as in figure 2.

These sparks are analogous to meteors or shooting stars. These meteors, masses of iron and practically free from carbon,

have been travelling about in space and suddenly coming in contact with the air which surrounds the earth sufficient friction is set up to heat the meteor to a temperature where the iron in it combines with the oxygen in the air. In other words, the iron burns and this burning produces light. It will be noticed that the light produced in the case of wrought iron is a straw color.

Figure 2 shows the sparks from mild steel. There is very little difference in the color from that produced by wrought iron, but the explosions and spurting are more numerous and profuse.

Figure 3 represents the sparks from tool steel, the number produced being greater and the spurting still more noticeable than from mild steel. The color characteristic also is changed from light straw to nearly white.

Figure 4 gives an idea of the sparks from high carbon steel. In this instance practically all characteristics of the iron have left and nearly all the sparks are spurting, many respurting a number of times. It will also be noticed that the distance the sparks travel away from the grinding wheel has also diminished. In high carbon steels the iron and carbon are in such form that they most readily combine with the oxygen in the air. Without the necessity of going into detail in connection with the other metals shown on this chart it can be seen that whereas Mr. Buckley's problem was not an easy one, still it is quite possible. In connection with the sparks produced from high speed steel although this particular metal possesses a fairly high percentage of carbon, the chromium and tungsten it usually contains have the function of holding the carbon in such a state that the sparks characteristic of ordinary tool steel are entirely absent.

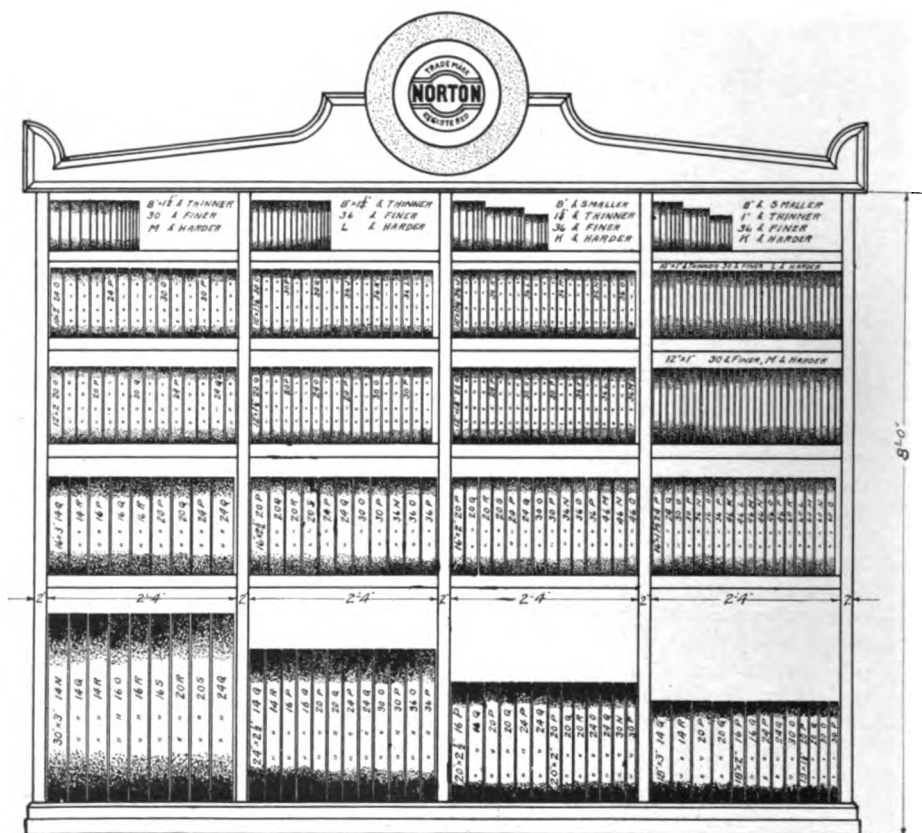
The sparks follow a straight line similar to wrought iron sparks but give very much

less light and end abruptly in a chrome yellow pear-shaped mass.

There are, of course, many other elements which naturally enter in connection with the reclamation of high speed steel. It can be seen, however, that the grinding of the metal does play a prominent part but this characteristic can be made use of not only in a commercial way, but by the toolmaker, for example, who has to handle different kinds of steel. Should a carbon steel be given the heat treatment required by high speed steel it would be ruined; or should a high speed steel be given the treatment proper for an ordinary carbon steel it would not work at the highest efficiency. By using as standard steel of known properties, one about which there is doubt can be readily picked out by means of a spark test.

It would be interesting to hear from any of our readers who have perhaps in their own factory put this spark test to practical use and whether they find that they have been successful in so doing. It is a subject worthy of considerable research work and there is little doubt that any investigation along this line will well pay for the amount of energy and expense one may care to expend.

Sometimes in a shop a line shaft will be speeded up to meet the requirements of one or two special machines. It often happens that there are also grinding machines dependent upon this same shaft. Naturally the grinding wheels under the changed speed conditions will act differently. This is a good point to bear in mind when rearranging your drive shafting.



A Practical Grinding Wheel Rack

This sketch is reproduced from our new pamphlet, "Storage, Handling and Supervision of Grinding Wheels."

It illustrates a typical layout of wheels which has proved satisfactory through many years' trial by Norton Company.

A construction blueprint of this type of rack will be sent to any one interested.

The pamphlet is also available on request.

Another Safety Suggestion



We are indebted to the "Bethlehem Booster" for this picture of Mr. Molton Dorward, foreman in the Armor Plate Department of the Bethlehem Steel Corporation, and for the suggestion which the picture carries.

Twice a month in Mr. Dorward's Department all cutting tools showing signs of ragged edges are handed over to the toolroom man who grinds off the rough places and cuts down chances of accidents from flying bits of steel. The before and after grinding appearance of the two cold cutting chisels shows not only the possibilities of the idea from a safety standpoint, but it leaves the impression that the efficiency of the tool itself is increased. Surely it has benefited in appearance. Why not add this idea to your own list of suggestions for improving shop conditions?



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the
Grinding Industry that Have Appeared in
Recent Issues

"Seek-Arbor Attachment" for Saw Grinder. Wood-worker, March, 1919, page 38. Detailed description of a home-made attachment.

Machine for Grinding-In Large Cocks. American Machinist, March 20, 1919, page 553. This machine was built by the Jarecki Mfg. Co., Erie, Pa., for its own use.

Blanchard No. 10 Vertical Surface Grinding Machine. American Machinist, March 20, 1919, page 565. Lengthy description of a new grinding machine just placed on the market by the Blanchard Machine Co., 64 State St., Cambridge, Mass.

Wood-Working Knife Grinder. Canadian Machinery, March 20, 1919, page 284. The machine used for the regrinding of knives for wood-working machinery is an ordinary floor grinder with a wheel about 18 to 20 inches diameter.

Liberty Grinding Attachment. American Machinist, March 27, 1919, page 618. This grinding attachment marketed by the Liberty Tool and Gauge Works, Woonsocket, R. I., is designed to be attached to surface grinding machines for the purpose of using wheels of small diameter running at high speeds.

Cylinder Grinding. Machinery, April, 1919, page 711. An account of the methods and machines used for this class of work in plants which make automobile and airplane engines.

Gage for Grinding Taper Spindles. Machinery, April, 1919, page 732. Description of a gage used to gage the ground tapered top of spindles which must be ground precisely.

Special Operations in Milling Machine Manufacture. Iron Trade Review, April 3, 1919, page 803. An account of the steps in the manufacture of these machines at the Cleveland Milling Machine Co., Cleveland, Ohio. The grinding operations consist in finishing the over arms and all important cylindrical parts.

Manufacture of Hoke Precision Gages at the Bureau of Standards. American Machinist, April 3, 1919, page 625. This process has been considered a military secret until the present time. Gage blocks are being produced with an accuracy limit of a few millionths of an inch. A Blanchard vertical surface grinding machine is used in two of the operations and a No. 10 Brown & Sharpe cylindrical grinding machine in another operation.

Angular Plug-Gage Making. American Machinist, April 3, 1919, page 635. When machining the gages the measuring ends are left cylindrical to facilitate the finishing of the rounded corners, and after hardening, these ends are ground and lapped to size. The grinding operation is described in detail, and suggestions for the various wheels to be used in this process are given.

Government Inspection of Machines and Small Tools. American Machinist, April 3, 1919, page 647. Some of the requirements of the War Department in the matter of inspecting machine tools are given in this article. One section is devoted to the standards of accuracy demanded for cylindrical grinding machines.

If you find that a dressing diamond is acting particularly soft when in use on your larger cylindrical grinding wheels turn it over to your tool and cutter department. The softer wheel structure is not as severe on the stone and more value from your diamond will result.

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Our present good intentions are to send you a similar message to this year's month.

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Grits and Grinds

Vol. XI

May, 1919

No. 1

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THIS MONTH "GRITS AND GRINDS" CELEBRATES ITS TENTH ANNIVERSARY

In May 1909 there was published a four-page flier intended as a news bulletin for the sales force of the Norton Company. As time went on, this idea of service developed until it included not only the sales force, but agents and dealers, and the wheel using public whose interests as consumers necessarily became linked with those of the producer.

"Grits and Grinds" is a technical paper, devoted exclusively to the treatment of subjects on grinding, grinding wheels, and grinding machines. The grinding wheel industry in a scientific sense is a comparatively new industry which is undeniably connected with all fields of manufacture. The universal demand for this product necessarily involves a variety of individuals to whom grinding problems are constantly presenting themselves—works managers, superintendents, foremen, grinding hands—each one with a specialized interest and, what is very probable, questions that must be answered.

"Norton Service" is more and more becoming the countersign which passes the consumer into the intelligent usage of grinding wheels. Scarcely anywhere can there be found in so highly developed a form the laboratory system which has made possible the countless number of experiments in connection with finding the wheel and the method for producing the maximum efficiency of work at the lowest possible cost. The Norton files are rich with information collected by grinding wheel engineers and demonstrators through contact with grinding problems in every industry and involving every metal. And it has been the mission of "Grits and Grinds" to act as a medium of expressing and spreading this information.

Such service is intended for the benefit of every Norton wheel buyer and user. It is therefore fitting that "Grits and Grinds" on its tenth anniversary express to all its readers the wish that it may continue to give that ready service which has been called helpful. It pledges itself to continue in the endeavor to meet the demands put upon it.

Internal Grinding in Locomotive Shops

By P. A. BRIDGMAN

In comparison with the ordinary run of machines the work done on a locomotive's mechanical makeup is crude.

The necessity for extremely delicate work in machining engine parts has not been apparent. No unusual attention has been paid to the details of accurately finishing the various motion parts.

Recent propaganda, however, regarding conservation of energy, saving of fuel, and less lost motion, has been reflected in the more up-to-date locomotive shops by the installation of grinding machines. These machines have been installed to produce a superior finish on various surfaces which heretofore have been turned, reamed, or lapped.

Internal grinding machines have come into the shops to stay, more particularly the heavy type of machine, the universal or tool room grinding machine lacking the rigidity necessary for locomotive work where speed is necessary.

Two heavy types of machines are proving their worth are the internal chucking grinding machine on which the work is revolved, similar to the method followed on the tool room grinder, and the type with the eccentric spindle on which work is placed in a fixture. On account of the large size and irregular shape of many locomotive parts, they cannot readily be revolved, and hence the eccentric spindle or cylinder grinder is usually best adapted to railroad-shop work.

A machine of this type may be seen in action in figure 1, finishing a bearing in a valve motion link. It may be noted that the grinding wheel bears

against the right side of the hole. As the cylinder B revolves one-half turn, the wheel will bear against the left side, thus making a circle, touching all points of the circumference of the bushing to be ground. In practice, adjustments are made to the table so that the grinding wheel will just touch the inner surface to be ground at all points. As the hole is gradually ground, the amount of eccentricity of the spindle is increased by turning the nut D. With this form of machine, holes from 1½" to 12" diameter may be finished. The table for holding the work has a longitudinal motion, controlled by the customary form of tripping dogs, which cause the table to travel back and forth in a manner similar to that used on the general run of grinding machines.

Holes in Valve Motion Levers and Bushings

There are many parts of a locomotive where it is possible to make use of the internal grind-

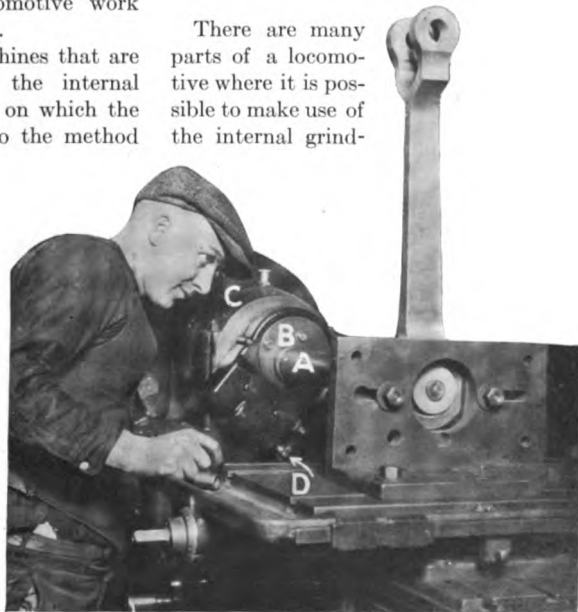


Fig. 1—Finishing a Bearing in a Valve Motion Link

ing machine, either in the original makeup of the machine or in doing repair work. Particularly in repair work is the machine of great use, as there is no question that there is a great saving in time and money, to say nothing of the fact that a better job may be performed which necessarily means fewer renewals.

Take for example valve motion levers, parallel rods and various other similar parts. The holes in the rods, or in the bushings or bearings applied to them, are often found worn oblong or rough, or the holes in the levers are distorted as a result of the bushing becoming loose in the levers. In many cases the holes may be trued and thus avoid renewing the bushings or reaming the lever. Reaming would in some cases be the quicker operation, but it would not produce as true a hole and would result in enlarging the hole more than by grinding, thus shortening



Fig. 2—Taking the "Pound" Out of Locomotive Side Rods

the useful life of the levers or rods. For the purpose of grinding these holes in the levers, the piece may be clamped to an angle plate located on the machine table.

In addition to valve motion levers, the holes in side rods, knuckle pins, bushings and a number of larger holes may be ground. Another use for this machine is

that of grinding the round holes in links into which the pins fit and also the holes in the link blocks. These are often case-hardened and when they have become



Fig. 3—Finishing the Hole in Bronze Bushing that has been Forced into Place within the Equalizing Cylinder Used in connection with Airbrake

worn in service, or when they have been warped in case-hardening, it is much easier to true the holes by grinding than by any other method.

In figure 2 may be seen the internal grinding machine at work grinding holes in side rods which will be made perfectly round and true before pressing in new bushings. The benefits of this may be easily imagined, it being much easier to press new bushings into a perfectly round and smooth hole, with the necessity for the usual continued renewals being removed. The greatest benefit in connection with this particular article is the fact that it does away with the "pound" in the locomotive.

Airbrake Parts

In addition to the internal grinding mentioned above this form of machine may be profitably employed on various airbrake parts, among which for example, are triple valves. The inner surfaces of the

cylinders where the piston travels should be refinished accurately and smooth. This desired surface can be obtained very quickly on the internal grinding machine and the work will be much superior to boring or reaming. Figure 3 shows an internal grinding machine finishing the hole in a bronze bushing that has been forced into place within the equalizing cylinder used in connection with the air-brake. This has been also used by the Pennsylvania Railroad, New York Central, and others for regrinding worn bushings of triple valves used in connection with airbrakes.

To refinish a very badly worn cylinder it may require more time than on a boring machine on account of the large amount of metal to be removed in order to true up the entire surface. Even so, the grinding would generally be more economical when considering the life of the cylinder. When boring there is always the possibility of the workman setting the boring tool to a larger diameter than is necessary to true the cylinder in order to get below the hard surface. With

grinding this danger does not exist, for the hard surface does not affect the grinding and the workman will naturally not do any more work than is necessary.

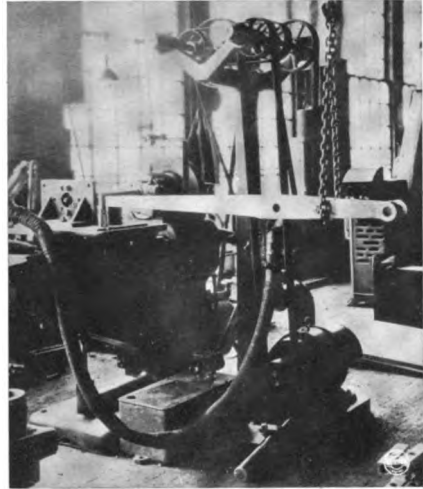


Fig. 5—Grinding Small Holes in Radius Rod Ford Locomotive Valve Gear

Some of the other uses to which the internal grinding machine can be put in locomotive shops are: (1) getting a true round hole in the hard bushing; (2) in the side rods where the bushing bore has become slightly elongated near the surface the hole can be made perfectly round and true before pressing in a new bushing; (3) grinding small holes by making use of an extension arm or quill, which goes with the equipment of this machine and enables the grinding of holes smaller than the standard arm will take.



Fig. 4—Grinding Reverse Shaft Bearing in Motion Work Saddle Used in Connection with Walschaert Valve Motion



Alundum Tile—Slip Proof

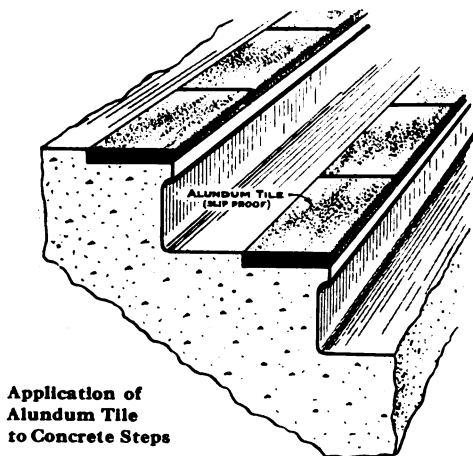
A New and Important Adaptation of the Alundum Electric Furnace Abrasive

There is hardly an industry that does not, in some degree, owe something to the development of Alundum abrasives. Alundum products occupy a position of importance in such industries as the manufacture of the automobile, the lo-

ducing the slipping and tripping hazards and the tremendous waste through compensation, hospital, medical and other expenses are finding in Alundum Tile a solution. With this Tile they are enabled to reduce [this economic waste by correcting unsafe conditions.

Those who have found that Alundum products possess unusual wearing qualities can readily appreciate that these same qualities of hardness, toughness and sharpness which have made them such a vital factor in the metal industries, insure durability and slip-proof effectiveness in a floor tile.

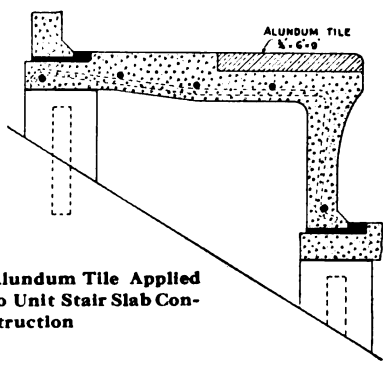
Alundum Tile is made by the vitrified process in various sizes, the more common being $\frac{3}{4}$ x 6 x 9"; $\frac{3}{4}$ x 6 x 6" and $\frac{1}{2}$ x 3 x 4 $\frac{1}{2}$ ". It fills the need of the architect for materials combining slip-proof effectiveness with architectural attractiveness and endurance. It is applicable to concrete, brick, wood, marble, granite and metal. It possesses many advantages such as uniform composition throughout, slip-proof permanency during its entire life, a permanent slip-proof nose, a plane surface with no grooves, corrugations, or depressions to permit tripping or the accumulation of refuse.



Application of
Alundum Tile
to Concrete Steps

comotive, agricultural implements, wood working machinery, printing presses, type setting machines, office devices, machine tools and hundreds of others. With the development of these modern abrasives, along with modern grinding machines, came the development of steel alloys, too hard and too tough to be machined, such as chrome steel, nickel steel and manganese steel. In a somewhat lesser degree these modern abrasives have been effective in the pearl and marble industries.

The thousands of users of these products will now be interested to learn that the same qualities that have resulted in the tremendous success of Alundum products in the manufacturing world have recommended it to a widely different use. Architects and engineers who have been confronted with the problem of re-



Alundum Tile Applied
to Unit Stair Slab
Construction

It is not introduced without having had its wearing qualities severely tested. Accurate measurements after thirty million people had passed over Alundum treads in one of the busiest New York subways showed that the wear on the Tile has been negligible. It has also been subjected to exhaustive physical tests at Columbia University, New York, a complete report of which has been published. Verbatim copies of this will

be furnished upon request. A booklet has been published descriptive of Alundum Tile in which it is shown how the product may be applied to concrete, steel and wood stairs; how it may be used for inserts for landings and floors; inserts for vault lights; its application to elevator door saddles; trench covers; shipping platforms; and its use in connection with floors, ramps and door saddles. The book will also be sent on application.



Stairway at Nevins Street Subway Station, Brooklyn, N. Y.,
Equipped With Alundum Tile



Little Known Facts About Grinding

By HOWARD W. DUNBAR

Automatic vs. Hand Feeding

A great many operators are indifferent about the method of feeding the wheel into the work, and this attitude brings varying results in the finish ground product. There is entirely too much tendency on the part of those operating grinding machines to use a hand feed in bringing the wheel in. This results in irregular feeding and calls for undue service from the wheel.

In previous articles it has been pointed out that the relation of wheel speed to work speed and the amount of feed are responsible entirely for the degree of efficiency with which that wheel operates. If this hand feeding, which varies from time to time, is persisted in, naturally the wheel, under certain conditions, will not act efficiently. Those conditions arise when the wheel is fed too deeply into the work for the grain and grade and speeds used.

All good grinding machines are provided with automatic feeds and these automatic feeds are so arranged as to regulate the amount of feed that the wheel advances

with each revolution of the work, or each stroke of the table, there being different kinds of feeds which vary either at each end of the stroke of the table or at each revolution of the work. These predetermined and regular advancements of the wheel allow such a wheel to act under its normal and effective conditions, resulting in a greater output, longer life of wheel and increased quality of product.

Many times chatter marks can be traced to hand feeding. The operator may be pressed for large production and brings his wheel in rapidly, in order that he may perform with his hands other operations, such as dogging the work. This allows the wheel to fill with steel and cut irregularly on the face. When the cut is allowed to die out, chatter marks, mottles, or blemishes in the work are produced.

Production is also affected by these conditions. It is universally true that where the automatic feed is adhered to religiously, production is at its highest point and quality is always the best.

With irregular speed of wheel minute particles of material being ground adhere to the wheel face. This causes the wheel to cut less freely, with the result that production is delayed and more power is required.

Versatile "Dutchy" Lehmann Whose Specialty is Grinding

You all know that period in the history of a company spoken of as, "why, I can remember when, etc." Back in those days



H. W. Lehmann, Cleveland, Ohio

when you didn't need half a week and an iron constitution to make a trip through the plant Harry W. Lehmann came to work for the Norton Company.

The memorable date was December 26, 1906, the year previous having been spent with Pratt and Inman, Worcester, Mass., where the coming Norton salesman for Cleveland territory first tackled business after leaving business college.

The "old timers" will remember "Dutchy" Lehmann and we hasten to explain to new readers that he derived this nomme-de-nick from his ability to impersonate the type on the minstrel stage where he showed unusual ability as a mimic.

Those were the days when the Alundum and Crystolon quartets used to grind out harmony. The Alundum four were the original disturbers of the peace, but, not to be outdone, "Dutchy" got some other music abrasers together and formed the second gang. Whether they took the name Crystolon because this product does its best only when well lubricated, we do not know.

"Dutchy" in his more serious moments acted as secretary for Works Manager George N. Jeppson. With five years of this experience and a fund of general information which this association had made possible he left for Germany October 22, 1911.

Mr. Lehmann states that he "engaged in missionary work" in A. H. S. territory (Germany, Holland, and Switzerland) until September 1913.

His work must have been successful as the war broke out almost immediately. "Dutchy," however, disclaims all responsibility.

During 1914 he was with Norton Grinding Company, joining later the E. W. Bliss Company as an expert on shell work. He worked in three different districts on this specialty until March 1916 when he joined the sales force of Mr. A. R. Sandine in district 8 with headquarters at Cleveland.

Mr. Lehmann is particularly well equipped for his work. His experience at the Norton plant, his observation of foreign methods, with the opportunity for comparisons with methods used here, his knowledge of grinding machinery—all contribute to making Mr. Lehmann what he is generally regarded—a well liked and valuable representative of Norton Company.



Notes from the Files of Sales Engineering Department

Monel Metal

Monel metal is an alloy consisting of approximately 67% nickel, 28% copper, and 5% other metals. It can hardly be distinguished from pure nickel in color and in tensile properties it closely resembles steel, as can be seen from the following table:

	Monel Metal Castings	Steel Castings
Melting Point,	2,480° F	2,500° F
Hardness (Scleroscope),	20—23	22—25
Tensile Strength,		
	72,000 lbs. per sq. in.	60,000 to 80,000 lbs. per sq. in.

Monel metal is tough and ductile and can be machined, forged, soldered, brazed, and welded by the electric or oxyacetylene method.

It lends itself admirably to casting and many very intricate patterns have been successfully cast. In rod form, its tensile strength is also high and it may be worked with equal facility either hot or cold.

In addition to its resistance to corrosive conditions, monel metal also resists oxidation due to its high nickel content, since nickel possesses in a high degree the property of withstanding the oxidizing influences of hot gases. Monel metal is used extensively for turbine blades and its selection is largely due to its great strength at high temperature, its resistance to the erosive action of steam and its resistance to corrosion. It is also used extensively for pump liners, rods, and valves, because of its extreme toughness and its resistance to abrasion and corrosion.

Other uses of monel metal are in dyeing machinery, where the metal must withstand strong acid or alkaline solutions;

pickling-tank fittings; golf club heads; needle valves in carburetors; tubes, wire cloth, and wire rope.

Monel metal machines with a long tough chip, in this respect resembling copper, but requiring somewhat more power to cut. For this reason the finishing of monel metal by means of grinding wheels or artificial abrasives is to be recommended. For the cylindrical grinding of this material on precision grinding machines, the usual grinding lubricant should always be used. Successful results are usually obtained with an Alundum vitrified wheel, grain 46, grades L or M or 24 combination, grades L or M.

For snagging castings composed of monel metal on floor stand or swing frame grinding machines, Alundum vitrified wheels, grain 16 or 20, grade Q, or grain 16, grade R, usually give satisfaction.

For cleaning heavy monel metal castings with a flexible shaft or portable electric grinding machine, our small 6" or 8" diameter wheels from $\frac{3}{4}$ " to $1\frac{1}{2}$ " thick, grain 24, grades R or S Alundum vitrified have been used with success.

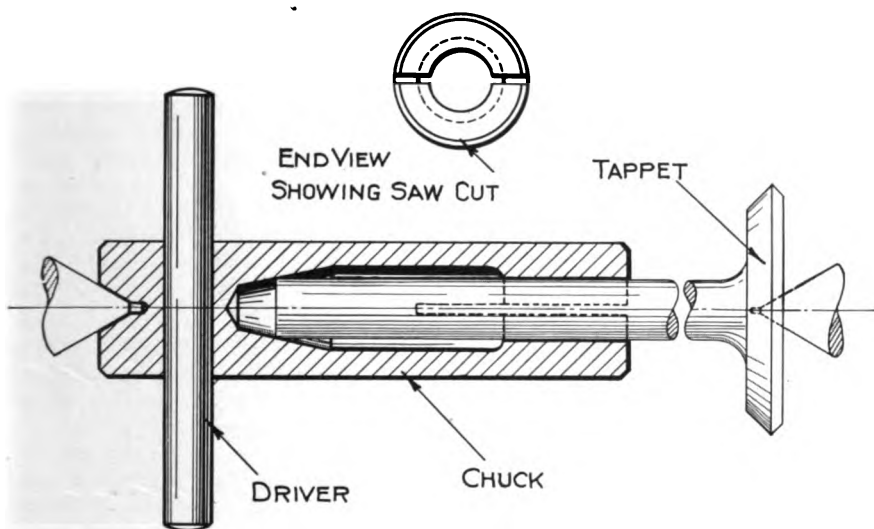
There is a certain demand for thin rubber bonded grinding wheels for use on abrasive cutting-off machines, for removing gates and risers from castings, and also for cutting rods, tubes, and wire. For these, we recommend 16 or 20 grit Alundum rubber wheels from 10" to 12" diameter and from $\frac{3}{8}$ " to $\frac{1}{8}$ " thick.

The Bayonne Castings Company of Bayonne, N. J., is equipped to produce monel metal castings of any size up to 25,000 pounds in weight in one piece. They also publish a very interesting booklet showing the uses to which this metal may be put.

Grinding Kinks

By HOWARD W. DUNBAR

Valve Seat Grinding



The problem of valve seat grinding has been solved in one factory by the little fixture here illustrated. The operator pushes the valve stem into this holder until it bottoms, which is the determining factor in positioning the valve. The center and driver are provided in the

holder itself. The front end of the holder is split and it can be sprung in slightly so as to give a grip on the valve stem. Then the grinding of the seat can be accomplished in the usual manner by swivelling the table of the grinding machine.

The wheel maker is constantly endeavoring to find the best relation of machine and wheel to produce the best results. Therefore, he should be authority for the grain, grade, and speed of wheel.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the
Grinding Industry that Have Appeared in
Recent Issues

Grinding a Master Hob. Canadian Machinery, April 10, 1919, page 355.

Rotary Surface Grinder. Iron Trade Review, April 17, 1919, page 1019. Developed by the Bristol Machine Tool Co., Bristol, Conn.

Holding Fixture for Grinding Flat Gages. American Machinist, April 17, 1919, page 755. This fixture was designed to enable a semiskilled grinding machine operator to hold slightly distorted gages for grinding with absolute certainty of no change taking place after releasing the clamps.

Janette Electric Grinding Stand. American Machinist, April 17, 1919, page 765. Marketed by the Janette Mfg. Co., 617-625 West Jackson Boulevard, Chicago, Ill.

Design Grinder for Use Without Centers. Iron Trade Review, April 24, 1919, page 1090. A grinding machine has been designed by the Detroit Tool Co., Detroit, Mich., for finishing all kinds of straight cylindrical work from $\frac{1}{4}$ " to $1\frac{1}{4}$ " diameter in any length. Instead of being supported during the grinding operation by centers, the work is ground by sliding in through a guide block until it comes in contact with the grinding wheel at which time the wheel automatically starts to rotate the work.

Dial Feed Arrangement Used in Grinding Piston Rings. American Machinist, April 24, 1919, page 803. Account of a quick method of feeding piston rings by means of a dial attached to a machine for grinding them on the side.

Landis Self-Contained Crankshaft Grinding Machine. American Machinist, April 24, 1919, page 813. New type of grinding machine placed on the market by the Landis Tool Co., Waynesboro, Pa.

Bristol Piston-Ring Grinding Machine. American Machinist, April 24, 1919, page 816. The latest product of the Bristol Machine Tool Co., Bristol, Conn.

How Would You Prevent This Grinding Trouble? American Machinist, April 10, 1919, page 705. A part is made of a piece of cold-rolled steel $\frac{1}{4} \times 2\frac{1}{4} \times 12$ in. long, to one side of which is riveted a cast-iron bracket. After the riveting is done it is desired to grind the flush side to a smooth finish over its entire length, including the rivet heads. Trouble is experienced by the warping of the steel on account of the release of surface strains. Other steel could be used if it could be obtained with a fairly smooth surface and with edges square. Can you tell how to accomplish the operation without encountering the difficulty described?

Grinders for Superheater Unit Joints. Railway Mechanical Engineer, April, 1919, page 214. These shop-made grinders are made by placing suitable pieces of broken grinding wheel in a suitable mold and then pouring the lead or babbitt around them. It is claimed that a set of superheater units can be ground with these tools in about one-third of the time ordinarily required with the regular grinders using oil and emery.

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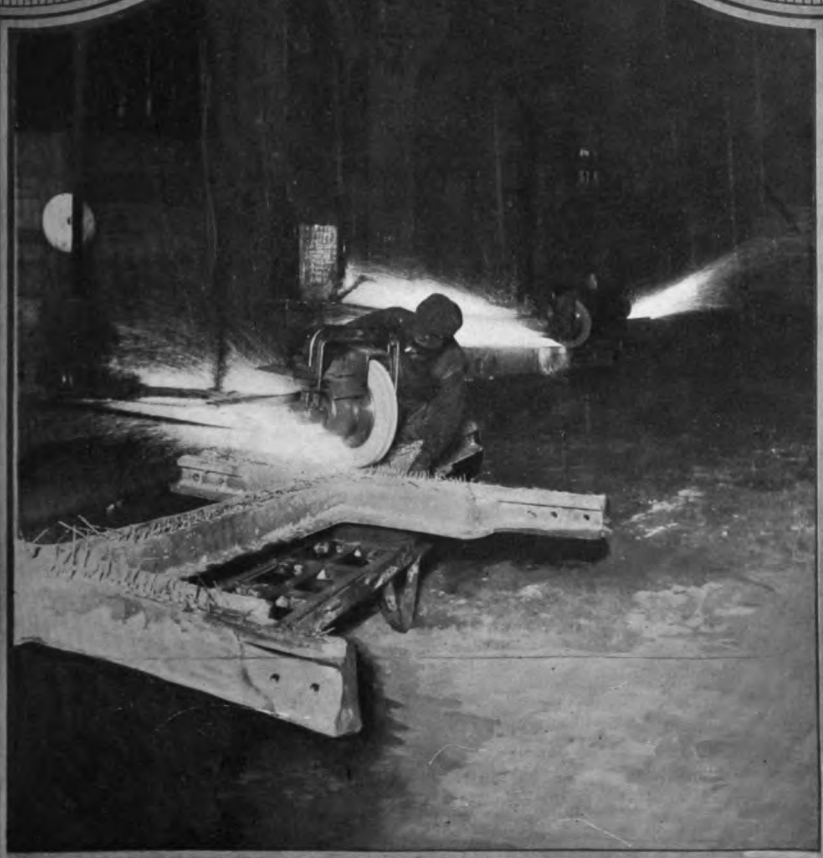
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Grinding Manganese Steel Castings

PART I

By R. M. JOHNSON

Before discussing the machining of manganese steel castings by grinding, it may be well to go into the history and properties of this alloy, an understanding of which will make clear the reasons for the methods used in machining and will also give an interesting comparison of this steel and ordinary carbon steel generally used for castings.

Manganese steel containing 10 to 14 per cent manganese was originated by Robert A. Hadfield, of Sheffield, England, in 1886. This discovery resulted in a material whose great hardness and ductility were unknown up to that time. It established the principle that because a certain amount of a given material produces a given effect upon steel, it does not necessarily follow that a different amount will give the same effect in a different degree. As in the case of the effect of manganese on steel, a different amount may give an exactly opposite effect from that obtained with a smaller or larger quantity.

The presence of over 1 per cent of manganese causes the metal to become hard and somewhat brittle. These properties increase in intensity with each increase in the manganese content until at 4 to 5.5 per cent the steel can be powdered

under a hand hammer. From this point to 7 per cent, these properties do not increase and at 7 per cent an entirely new set of qualities begin to appear. There is an increase in strength and ductility until about 14 per cent manganese is present, at which point these properties reach a maximum. In this discussion we shall consider a steel containing 12 to 14 per cent manganese.

This material after it has been cast in an ingot or mould and slowly cooled is very brittle. However, after reheating to a white heat and plunging into water, a treatment which makes ordinary steel brittle, this steel becomes very hard, tough, and ductile.

These properties make manganese steel the most durable metal known in its ability to resist wear. As it is impossible to roll such steel, all parts must be cast. These castings can be forged with difficulty at a temperature somewhat above a red heat. They cannot be machined or drilled with steel tools and all finishing must be accomplished by the use of grinding wheels or abrasive grain. It is somewhat difficult to cast as all holes must be cored in the casting and due to its enormous shrinkage, five-sixteenths inch per foot, no intricate shapes can be made. The shrinkage is

hard to control, making it necessary to have an excess of metal on castings which have to be finished accurately. This makes necessary a large amount of grinding.

The resistance to wear is due to its toughness and hardness which are in turn due to a peculiar property. The surface flows very easily under strong pressure, as for instance, that which it meets in the jaws of a stone crusher. In this flow it hardens to a great extent and very rapidly, so that a relatively hard wearing surface forms, an integral part of this surface being a ductile backing. This surface is self-renewing, for as fast as a given layer is worn away, the next, as it becomes the surface, hardens immediately under the pressure it encounters.

The tensile strength of this steel is not less than 100,000 pounds per square inch compared with 60,000 to 80,000 for ordinary open hearth steel.

A few common articles made of manganese steel castings are: frogs, switches,

crossovers, plowpoints used in road building, fluted and toothed crushers for ore and stone, screens for screening this material, herring bone mill pinions, dredge buckets, safes, and caterpillar tractor links.

SNAGGING THE ROUGH CASTINGS

From this short description of manganese steel, its properties and uses, it is apparent that grinding is of great importance in its manufacture.

The castings as they come from the foundry or cleaning room have had the risers, sprues, and some of the irregularities removed by means of sledge hammers or oxyacetylene torches. The torch is a very effective tool for doing this work and entirely replaces the chipping chisels which are used on ordinary steel castings.

At best, however, the castings are very rough, the fins sharp, and the material left where the cutting torch has removed the sprues and risers presents very jagged edges. An idea of the work the snagging

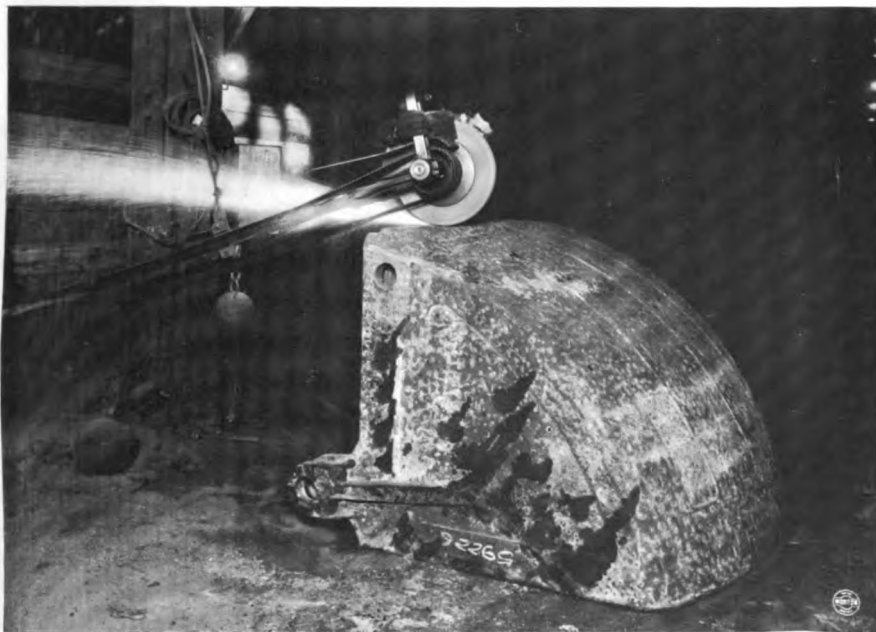


Fig. 1. Cleaning One-Half of a Clam Shell Bucket



Fig. 2. Removing Excess Material from a Dredge Tumbler

wheel has to do may be obtained by noticing the crossover and switch shown in the cover illustration. These conditions, with the properties of the steel itself, make this cleaning operation one of the hardest on which grinding wheels are used.

As in the case of ordinary steel castings, three different types of grinding machines are used: swing frame, floor stand, and portable. As many manganese steel castings range from 200 to 25,000 pounds in weight, the swing frame is most important. This machine is, no doubt, familiar to most grinders. It is a mounting so arranged that the wheel can be moved in any plane within the reach of the machine arm. Figures 1 and 2 and the frontispiece show swing frame machines in operation and a commonly used wheel, 20 x 2 x 2 inches, $\frac{3}{4}$ inch taper per foot, both sides.

Floor stands are of the double-ended type, mounting two wheels up to as large as 24 x 3 x 2 $\frac{1}{2}$ inches, either tapered or straight on the sides. The work performed on this type of machine must necessarily be small. Figure 3 shows two operators snagging manganese steel tractor links.

The third type, the portable grinder, is of three types: flexible shaft, electric, and pneumatic. These mount small wheels from 6 inches up to 14 inches in diameter and up to 2 inches in thickness for the smaller wheels. They are used for grinding in corners and grooves where larger wheels and machines cannot be employed.

Of the three methods of snagging described, the one making use of the swing frame machine is hardest on wheels. This is due to the enormous pressure which can be applied to the wheel mounted on this type of machine. In addition to this, the size and condition of the work ground are of vital importance.

There are, in snagging operations, two groups of factors affecting the action of grinding wheels. One group tends to make the use of hard wheels necessary, while the other group opposes this tendency. This causes us to use wheels which will satisfy to the best advantage both sets of conditions.

Under the group calling for hard wheels are included:

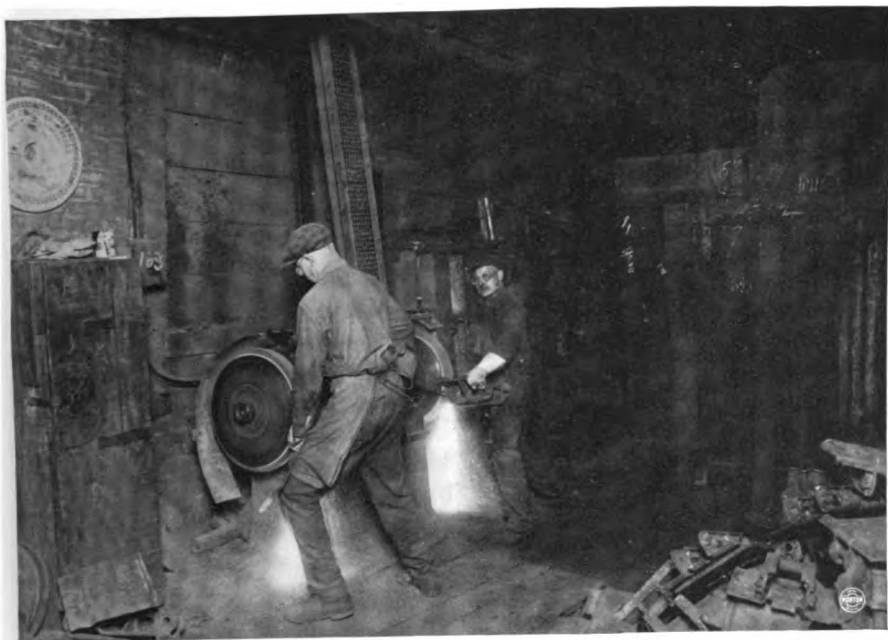


Fig. 3. Off-Hand Grinding of Manganese Steel Tractor Links

1. Desire for longer wheel life. At first glance it would seem that the longer the wheel life the cheaper the grinding cost. This is not true, as the use of hard wheels having long life causes a decrease in production, with the accompanying increase of overhead per unit of production.

2. Rough condition for the work caused by sharp fins and sprues. Notice the nails that have to be ground off the frogs and crossings shown in the front cover illustration. On the large castings which take a long time to cool, the sand from the mould is often baked or semi-vitrified, forming a hard scale on the surface. This is particularly hard on wheels and calls for extremely hard grades.

3. Enormous pressure applied to the wheels by the operator sitting or hanging weights on the swing frame arm.

4. Piece rate or bonus systems cause operators to "work the wheels hard" to increase their earnings. The harder the wheel the better it stands up under this abuse, although production suffers, caus-

ing an increase in grinding costs as explained under No. 2.

Tending to make necessary the use of soft wheels we have:

1. Workmen's desire for high hourly production with a minimum expenditure of energy.

2. Necessity for keeping the amount of heat generated during grinding as low as possible. An enormous amount of heat results from grinding manganese steel, owing to its extreme toughness and high tensile strength. Danger of breakage is always present where a great amount of heat is developed during grinding.

3. Desire for fast cutting or high hourly rate of production, in order to reduce overhead expense per unit of production.

To fulfill the requirements of the two groups, it is necessary for us to produce a fast, cool cutting wheel which will have sufficient life to keep the grinding cost to the minimum limit and be sufficiently hard to stand up under the very heavy grinding shown in the illustrations.

The three illustrations, frontispiece, figures 1 and 2, show several types of work which are being successfully ground



with a 20 x 2 x 2 inches, $\frac{3}{4}$ inch taper per foot both sides, grain 6614 grade U Alundum wheel.

Figure 3 shows two Norton wheels 24 x 3 x 2 inches, $\frac{3}{4}$ inch taper per foot, both sides, grain 10 grade T regular Alundum, being used for grinding tractor links. Notice the fast cutting quality of these wheels as shown by the amount of sparks produced.

For the portable machines a narrow wheel 9 inches in diameter by $\frac{3}{4}$ inch thick is representative. A grain 24 grade R wheel is commonly used for

grinding grooves in rails, and other general snagging work. Number 66 Alundum in the same grain and grade has replaced regular Alundum in one plant for this work.

Note: The editors wish to thank the American Manganese Steel Company, Chicago, Ill., for the use of the pictures illustrating this article.

To be continued in July issue

Gaging by Color the Work on the Surface Grinder

By P. A. BRIDGMAN

About once in so often a man who is too lazy to work according to prescribed instructions suddenly, and generally to his surprise, finds himself famous. In an attempt to get the maximum amount of production with minimum effort he hits upon an idea by chance which revolutionizes the particular machine on which he is engaged or in some way simplifies the method of work. From a commonplace individual he is pointed out as the man who did this or that and his name may even become great.

In the American Machinist for May 2, 1918, "A Gaging Kink for Surface Grinding," Mr. Fred H. Bogart introduces us to a man who developed a new wrinkle in surface grinding, apparently for the sole reason that he disliked getting his hands dirty.

To quote Mr. Bogart:

"It was a scheme of the operator himself, a man of no mechanical experience, but 'broken in' on that particular machine, to produce duplicate parts in large quantities. The machine had been equipped with a dial indicator, but it had been discarded as too uncertain of operation. The method the man

was using had been devised by him, not to increase or save his employer money, but to save himself the dirty job of cleaning and measuring a part two or three times every load of the table."

Many are the difficulties of gaging the thickness of work being surface ground on a magnetic chuck. Various devices are used but none are entirely satisfactory. This is due to the different conditions arising in the process of grinding large quantities of irregularly shaped pieces on a magnetized table. The best designed surface indicators will not stand up under constant use even for a short time, the direct reason for this being that any form of indicator sufficiently delicate to read to the thousandths of an inch is too delicate to stand up under the bumping that must necessarily occur as the contact shoe slides from piece to piece while the table traverses or revolves. Where the shoe is not adjusted to the work, to give a constant reading, the permanently affixed indicator has little advantage over the older method of taking one piece off and measuring it with a micrometer. Both methods require that the operator work

down to size by the cut and try process. Both necessitate the stopping of the table and the thorough cleaning of one piece before measurement is taken and these wasted periods, repeated as they often are three or four times before the required size is registered, aggregate more in most instances than the time consumed by the wheels in cutting away the material.

The only advantage of the permanently affixed indicator over hand measuring is that with the former the magnetizing current does not have to be shut off to take the measurement.

Mr. Bogart described the operation, which he describes as a "clever wrinkle," somewhat as follows:

"The operation was grinding steel discs about $\frac{1}{16}$ " thick to a limit of .003". Assuming the thickness dimensions were maximum .188" and minimum .185", the procedure of the operator was as follows. The first tableful of material he worked down as was the usual custom, by the cut and try method, and taking off one piece and micrometering it in accordance with his usual practice. After he had finished this and selected a single disc which measured according to proper specifications, he cleaned its surface with a little gasoline and blued it with a swab out of a bottle of solution which he kept handy and put it on the table with the second load. No matter how dirty

the water or work got during the process of grinding, you could always plainly see that one blue disc sweeping around the circle. During the early stages of the grinding the operator fixed a second disc, ready for his next load. About the time that he felt the material was nearing size, he watched the blue disc. The instant that the wheel touched it and the blue disappeared, the grinding wheel was at once raised and he could be reasonably sure that the parts would then measure between .186" and .187" and warrant cleaning off the table before making a measurement."

According to Mr. Bogart the man was turning out work with splendid accuracy and with very little wear and tear on his nerves and the only trick in the whole operation that could be observed was that of picking out a dummy disc measuring to the maximum thickness.

It is true that certain objections may be raised and criticisms made in connection with gaging work in this manner. On some classes of work it might be inadvisable owing to the fact that it would cut down production by reducing the unit capacity of the table. To be sure, if the table held only a few pieces, this would be worth consideration, but the quantity would not have to be very great to pass the point where the saving of time in measuring would more than offset the loss of space.

It is important that the grinding wheel fit the spindle or arbor closely to avoid play which throws it out of balance. Don't make the mistake, however, of forcing a wheel on its spindle, as even a slight strain may result in breaking the wheel. An allowance of .005 in. will usually be found to be about right.



Notes from the Files of Sales Engineering Department

Stellite

Until this alloy was originated and developed by Mr. Elwood Haynes, there had been no rival of steel which would take and hold an edge equal to that of the best tool steel tools. Stellite is composed principally of cobalt and chromium, with small amounts of tungsten and molybdenum added to increase its hardness. It is not a steel in any sense of the word, since it contains absolutely no iron.

One of the most remarkable properties of Stellite is its ability to retain a cutting edge at high temperatures. Because of this property lathe and planer speeds, which would be prohibitive when steel tools are used, may be employed. This explains why Stellite is being used extensively for lathe and planer tools, drill, boring tools, milling cutters, and metal slotting and cut-off saws.

Stellite has another highly desirable property. It takes a very high polish which rivals silver in brilliancy and luster. Because fruit juices, fruit acids, and antiseptic solutions, including bichloride of mercury, phosphoric acid, and iodine, have absolutely no effect on Stellite, it is coming into use for pocket and table cutlery and surgeons' instruments. Table knives made of this alloy have been in continuous use for a period of seven years and show absolutely no tarnish and practically no wear. A spoon showed no loss in weight after six months' use.

All machining must be with grinding wheels and, because the material is cast in most cases, there is a fairly large amount of stock to be removed.

The turning tools are made in three grades: No. 1 Stellite is the mildest, but also toughest and strongest; No. 2 Stellite is harder than No. 1, but similar in other properties; No. 3 Stellite is much harder

than either of the other kinds and possesses great wearing qualities, but is quite brittle.

No. 1 is used for mild steel up to 30 point carbon, No. 2 for 30 to 100 point carbon and soft cast iron, and No. 3 for malleable iron and both hard and soft cast iron.

Bar Stellite as it comes from the mold must first be snagged to a more finished bar. Using a 16 x 1½ x 1½" wheel grain 30 grade O Alundum vitrified, this work can be performed in an entirely satisfactory manner.

The next step in making lathe tools is cutting off the bars to proper lengths. This may be accomplished on a tool and cutter grinder or a cutting-off machine of the Slack type. Using wheels 12 x ½ x 1", grains 30 and 36, Alundum rubber stand up most satisfactorily and cut well. Elastic wheels in 46 and 60" grade 5 are also used to good advantage.

For off-hand surfacing the tool bits, using a 10 or 12 x 1" wheel, grain 30 grade M Alundum vitrified is satisfactory. With the same size wheels large tools are sharpened with grain 60 grade Q Alundum vitrified and small tools with grain 80 grade O.

Using an 8" wheel on a tool and cutter grinder for surfacing bar Stellite, 6646-J and 3846-J wheels are recommended, the former being the better wheel.

Milling cutters having Stellite teeth and soft steel hubs are surfaced on a Persons-Arter rotary surface grinder with a grain 46 grade M Alundum vitrified wheel. The teeth, of course, have a dressing action on the wheel on this operation in spite of which the corners held up well and the wheel gave a good finish.

After surfacing, the teeth are backed

off with a tapered cup wheel ($3\frac{1}{4}$ - $2\frac{1}{8}$) x $1\frac{1}{4}$ x $\frac{1}{2}$ ", 3846 grade K.

Three operations are necessary to finish a Stellite cutting-off or slitting saw. The hole is first ground with a 3846 grade K Alundum wheel. The sides are then rough surfaced, using a 6 x $\frac{1}{2}$ x $\frac{1}{2}$ " grain 3846 grade K wheel on a tool and cutter grinder. The finish grinding is done on a Persons-Arter machine with a 12 x 1 x 5", 3846 grade L Alundum vitrified wheel. The

gumming operation is satisfactorily performed with a 6" saucer wheel grain 3846 grade M.

At one plant Stellite tools are being sharpened on a Gisholt tool grinder, using a (10-8) x $5\frac{1}{2}$ x 4" grain 20 grade K Alundum vitrified wheel.

If you are having trouble grinding Stellite tools, the Sales Engineering department will be pleased to discuss the whole subject with you at any time.

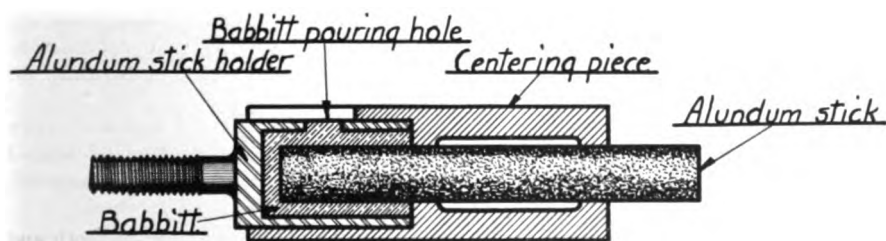
Centering Jig for Alundum Sticks

The frequent use of Alundum round sticks in metal holders will make the accompanying sketch of interest to all mechanics and tool room foremen.

Mr. T. T. Carlson of the Simonds Mfg. Company, Fitchburg, has found this centering jig a great help in getting the

Alundum sticks properly set in the holders.

There is a slot in the centering piece which permits pouring the babbitt to the inside of the holder when this slot is registered with the pouring hole. Other materials such as sulphur, bismuth, etc., may be substituted for babbitt.

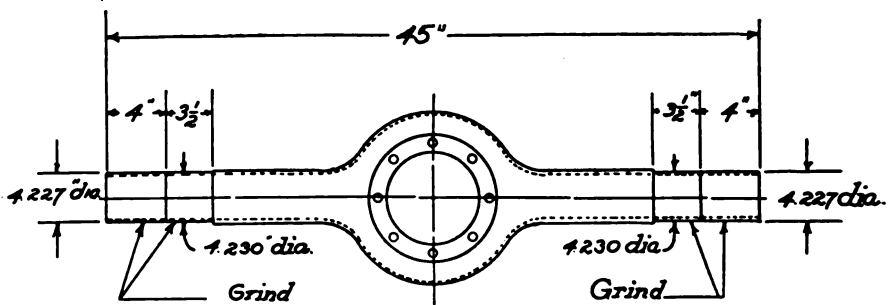


Section

Centering jig for Alundum sticks.



Sixty Housings in Ten Hours



Sketch 1

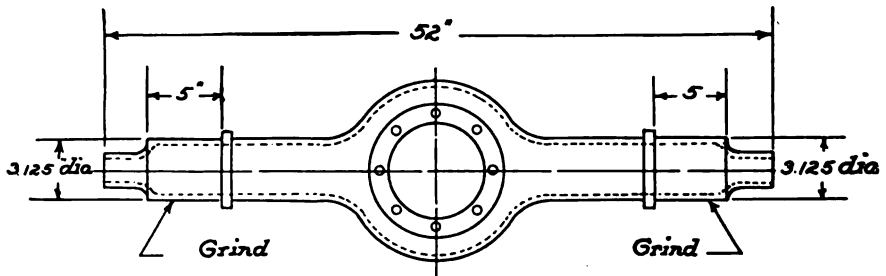
Sketch 1 shows a pressed steel rear-axle housing $\frac{1}{4}$ -inch thick. There are four diameters to be ground with a limit of .002-.040-inch stock removed (from black stock).

Using a $20 \times 4\frac{1}{2} \times 2\frac{1}{2}$ —24 C-M wheel on a 16 x 50-inch Norton Grinding Mach-

ine it is no unusual day's work for an operator to finish 60 housings in 10 hours.

If the reader has similar work and is not turning out the same number of housings, we may have some helpful suggestions which can be secured by writing to the Service Department of the Norton Grinding Company.

One Hundred Housings in Ten Hours



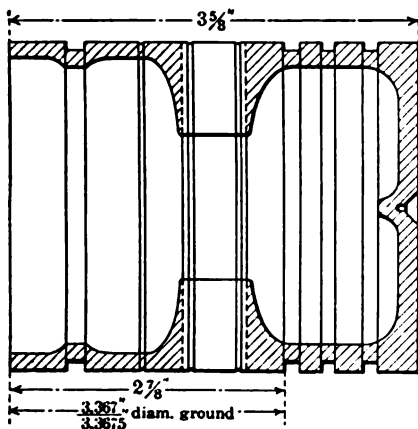
Sketch 2

Sketch 2, which is a different installation, has one feature in common with the housing shown in sketch 1, and that is excellent production in both cases. This rear-axle housing is pressed steel $\frac{1}{8}$ " thick, two diameters ground, with a limit of .002"-.040" stock removed (from turning).

On a 16 x 50 Norton grinding machine using a Norton wheel $20 \times 5\frac{1}{4} \times 12\frac{1}{2}$ " 24C-M there should be a production of 100 housings in 10 hours.

If this production is not being maintained, reference made as mentioned above may be helpful.

Five Hundred Pistons in Nine Hours

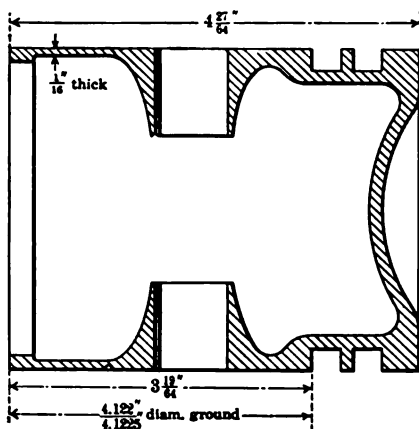


Sketch 1

Sketch 1 of an aluminum piston is drawn to show the possibilities of a Norton wheel used on a Norton grinding machine with unparalleled production as a result. In this instance there is a section $3\frac{5}{8}'' \times 3.367''$ diameter to be ground over, .025'' stock to be removed with a limit of .0005 total. The machine is a Norton 6 x 32'' plain, using a 14 x 3 x 5'' wheel with the pieces held in a live spindle attachment and turning out 500 pistons in 9 hours.

Two Hundred Fifty-Five Pieces in Nine Hours

We have in the second instance a sketch of a cast-iron piston, .030 stock to be removed with a limit of .0005, grinding over a section $4\frac{27}{64}''$ long by $4.122''$ diameter, using a Norton plain machine 10 x 36'' with a Norton wheel 20 x 2 x 5'', the pieces held by special holders on dead centers. The production here is 255 pieces in 9 hours. Both records mentioned have been broken by Norton wheels on Norton machines, but these sketches are put in simply to illustrate what should be the ordinary production in your shop.



Sketch 2



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

Small Motors for Hand Tools and other Uses. *American Machinist*, May 8, 1919, page 899. Several grinding operations are illustrated in this article.

How Would You Prevent This Grinding Trouble? *American Machinist*, May 8, 1919, page 878. Mr. J. S. Damon explains how he would do the work on a Simplex grinding machine, because it presents a broad flat surface which covers completely the surface of the article to be ground, and therefore accomplishes the grinding operation all at once.

Grinding Large Ring in a Boring Mill. *American Machinist*, May 8, 1919, page 903. The writer of this article describes the arrangement which he used to grind a ring in place on a fixture in a Lucas precision boring mill.

Taylor & Fenn Bore Grinding Machine. *American Machinist*, May 1, 1919, page 864. *Iron Age*, May 1, 1919, page 1160. *Machinery*, May, 1919, page 865. This bore grinding machine which is a product of the Taylor & Fenn Co., Hartford, Conn., is said to have a number of features not found in other machines. These special features are shown in the illustrations.

Automatic knife and edge grinder. *Iron Age*, May 1, 1919, page 1158. An automatic knife and edge grinder with a heavy cabinet base and sectional wheel has been placed on the market

by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. A feature of this machine is a sectional wheel chuck.

An 8-Inch Ring Grinder. *Iron Age*, May 1, 1919, page 1176. A new type of grinder with rotating magnetic chuck, designed for accurate and rapid grinding of flat surfaces of various sizes and shapes, either singly or in multiples, has been added to its line of grinders by the Bristol Machine Tool Co., Bristol, Conn.

Making the Timken Roller Bearing. *Machinery*, May, 1919, page 829. Part of this article describes the grinding operations on the outer raceways or cups and on the inner raceways or cones.

Security Internal Chucking Grinder. *Machinery*, May, 1919, page 882. The Security Tool Works, 115-117 South Clinton St., Chicago, Ill., have recently placed on the market an internal chucking grinder which has been designed to meet the demand for a heavy duty machine that is suitable for manufacturing purposes as well as for the tool-room.

Modern Universal Grinding Fixture. *Machinery*, May, 1919, page 886. The Modern Tool & Machine Works, Inc., 344-50 Mulberry St., Newark, N. J., have recently added to their line a precision tool adapted for the purposes of grinding milling cutters on either a surface grinder or a universal grinding machine.

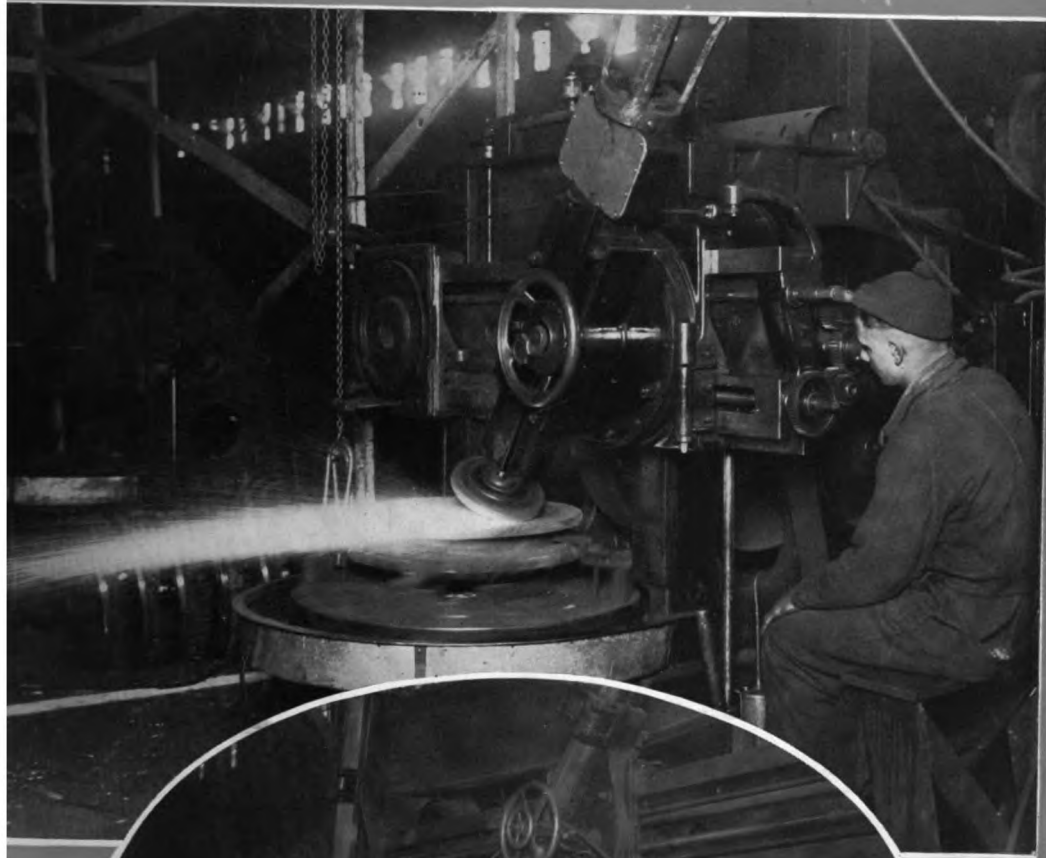
Grinding problems cannot always be solved by asking the other man what he is doing. A wheel that is perfectly satisfactory on one machine may not give good results on another. Don't think from this that there is anything mysterious about it, because there is always a good reason for everything that happens.

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Grinding Manganese Steel Castings

PART II

By R. M. JOHNSON

(Continued from the June issue)

The limits to which many parts made of manganese steel must be held are as small as those required on parts made of ordinary low carbon steel, which can be machined with steel tools on lathes, planers, shapers, and boring mills. Because there is no steel tool known at present that can be used successfully for machining manganese steel, grinding wheels must be used.

Cylindrical work, small enough to be mounted on plain cylindrical grinders, can of course be ground to very close limits, .00025 inch on the diameter or even smaller. The finish can be anything that is desired, rough, commercial, or very fine.

Figure 1 shows a Norton 36 x 96 inch gap grinder grinding a 16-inch herring bone mill pinion with a 24 x 3 $\frac{3}{8}$ x 5-inch 24 Combination grade M regular Alundum wheel. Grinding is, of course, done wet. This wheel is called upon to finish the fillets, causing considerable side pressure, a dangerous condition. Side pressure is liable to cause wheel breakage and should be eliminated where possible. Where it is impossible to eliminate side grinding entirely, great care should be exercised and the wheel allowed to cut itself free so that too

much pressure will not exist between the wheel and the work.

A lathe equipped with a grinding wheel mounted on a special fixture is also used for cylindrical grinding. Figure 2 shows a 72-inch lathe with which a herring bone mill pinion is being ground. For this operation a 24 x 2 x 2-inch, $\frac{3}{4}$ -inch taper per foot both sides, grain 16 grade P regular Alundum wheel has proved to be an excellent wheel. Note the large quantity of sparks, showing the fast cutting qualities of this wheel. The greater vibration in this type of machine in comparison with a cylindrical grinder shown in figure 1 makes it necessary to furnish a somewhat harder wheel.

The lower illustration on the front cover shows two wheels mounted on a 16-foot boring mill being used simultaneously for grinding the outside diameter, and the top of a dredge tumbler center. The diameter is ground to size while the top and bottom are smoothed off. Both wheels are tapered $\frac{3}{4}$ inch per foot both sides 14 x 1 $\frac{1}{4}$ x 2 inches 16 P or Q regular Alundum. Deep cuts are taken and the grinding done dry, making the use of a free cutting wheel not only desirable, but absolutely necessary.

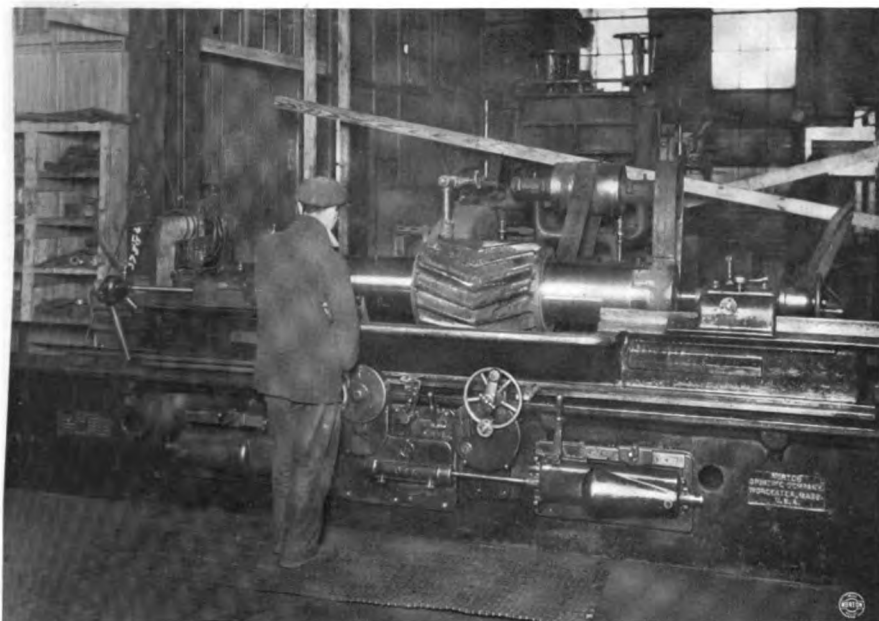


Fig. 1. Norton Grinder grinding a 16-inch herring bone mill pinion

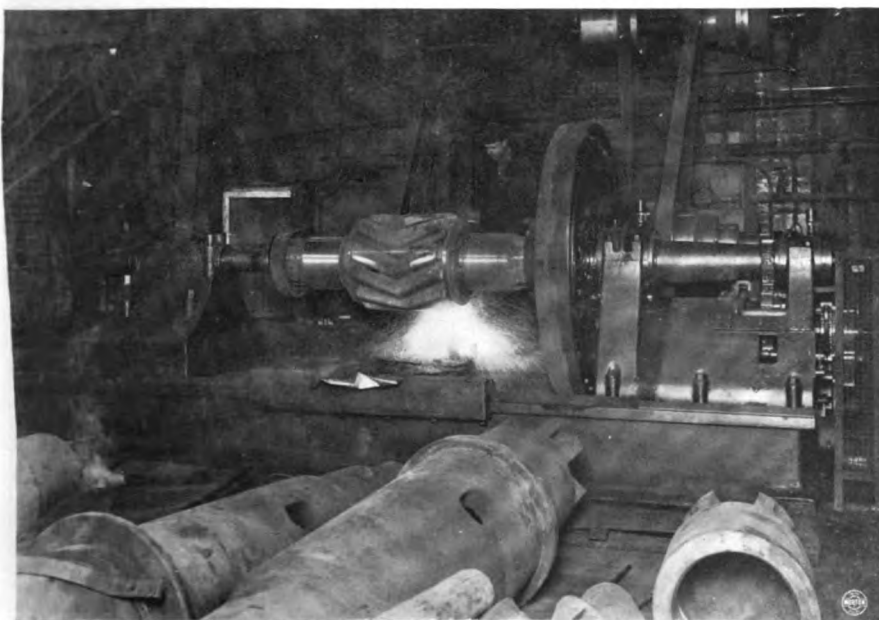


Fig. 2. A 72-inch lathe equipped with special fixture for cylindrical grinding
[JULY, 1919]

[3]

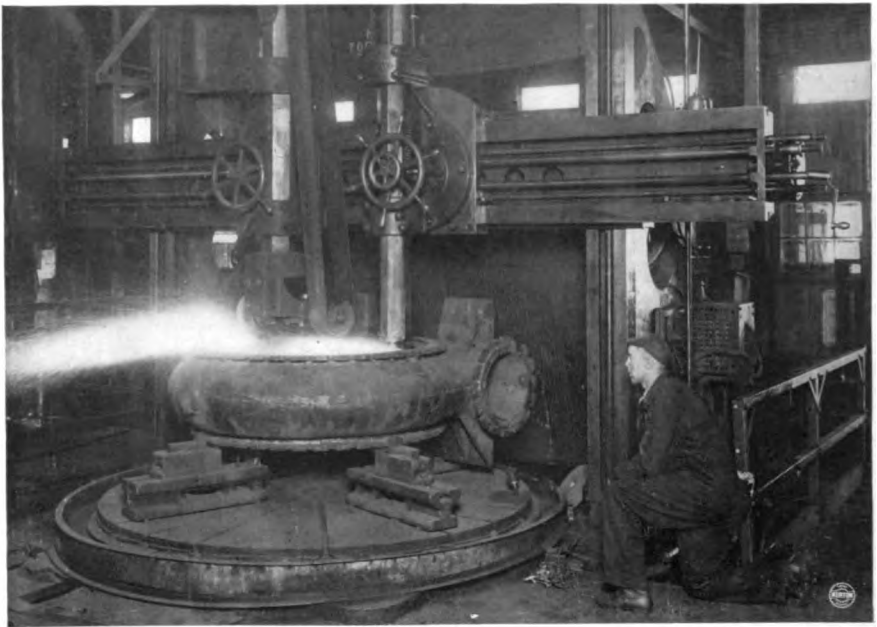


Fig. 3. A boring adapted to surface and internal grinding

Another surfacing operation being taken care of on a boring mill is shown in figure 3. The machine is a 42-inch King mill and the wheel a 14 x 1 $\frac{3}{4}$ x 2-inch, tapered both sides $\frac{3}{4}$ inch per foot, 16 grade P regular Alundum. The operation is the surfacing of a flange bevel gear.

Figure 4 shows another boring mill being used for two operations at the same time. One wheel is used for surfacing the top of the flange of a centrifugal pump casing and the other for grinding the hole to size. Both are tapered wheels, 14 x 1 $\frac{3}{4}$ x 2 inches 16 grade P regular Alundum.

In all of these so-called semi-precision operations, the wheels are automatically traversed and an enormous amount

of power put behind the wheel and table drive. Deep cuts are taken and the wheel must cut or give away under the pressure. No slow cutting wheels can be used. You will note in each illustration the volume of sparks gives sufficient proof of the cutting ability of Norton Regular Alundum wheels. As stated in the article on snagging in the last issue, there is no harder job for a grinding wheel than grinding manganese steel. Stock must be removed rapidly with a minimum of heating, a job successfully accomplished with Norton wheels.

Note: The editors wish to thank the American Manganese Steel Co., Chicago Ill., for the use of the pictures illustrating this article.

Speed of Grinding Wheels

By W. R. MOORE

Wheel Speed Theory

Why do we revolve a grinding wheel? First, to distribute the work of cutting over all the grains on the periphery and, second, to impart energy or capacity for work to the grit.

What is the correct speed for a grinding wheel? There is no arbitrary speed at which a wheel will perform better than at slightly higher or lower speeds. When we revolve a wheel at a speed that enables each cutting grain to do a maximum amount of work without breaking off or dulling too rapidly, then we have the correct speed for the wheel on the work in question.

But there are so many variables entering into each particular grinding operation that the selection of a suitable wheel would be next to impossible if we did not consider wheel speed as a more or less fixed value. And so years of observation and experience in the operation of wheels on different classes of work, also safety considerations and questions of wheel manufacture, make it advisable to recommend certain ranges of wheel speed for particular classes of grinding. We must have some basis from which to work, some starting point for our wheel selection.

Wheel speed to be recommended also depends upon the rigidity and condition of the grinding machine, the protection afforded the operator, the shape and weight of the grinding wheel, and the nature of the grinding operation.

Speeds slightly higher than the recommendations below call for softer grades to offset the harder cutting action; speeds lower than these recommendations call for slightly harder grades to compensate for the softer cutting action.

A wheel acts harder when its speed

is increased because more cutting grains are called into action in a given time. This division of the work of cutting over more grains makes each grain do less work per revolution of the wheel. This in turn means that instead of fracturing and leaving new sharp edges to do the cutting the grains may be dulled over, and the bond, being less disturbed, may retain the dull abrasive longer than it should. Such a condition tends toward glazing, which as we know slows cutting action and is generally detrimental to efficient grinding.

Conversely, a wheel acts softer when its speed is decreased because each cutting grain has more work to do per revolution of the wheel—thus tending to fracture the abrasive. Also, the bond holding each particle of grit is subject to greater wear with a resulting tendency to release it more readily.

Recommended Speeds

Observation of results has enabled us to determine on some general recommendations for safe operating speeds under average working conditions. Below is a list of the speed range for different classes of grinding:

	S. F. P. M.	
Cylindrical grinding,	5,500	to 6,500
Internal grinding,	5,000	to 6,000
Snagging and general off-hand grinding on bench and floor stands,	5,000	to 6,000
Surface grinding,	4,000	to 5,000
Knife grinding,	3,500	to 4,000
Hemming cylinders,	2,100	to 2,400
Wet tool grinding,	4,000	to 5,000
Elastic and rubber cutting-off wheels,	9,000	to 12,000



Safety Considerations

The practice in the manufacture of grinding wheels is to test all 6" in diameter and larger at a speed sufficiently above our recommended operating speeds to insure an adequate factor of safety in the matter of centrifugal stress. The majority of wheels, including straight and tapered sides, are tested at nearly twice the recommended operating speed. Cups and cylinders in the softer grades are not tested quite as high on account of their shape and concentration of weight. This, of course, is taken into account in our recommended speeds for these kinds of wheels.

Although it is made certain that every wheel is safe to operate at the recommended speed when it leaves the factory, no guarantee is given that it is in the same condition when the operator mounts it on his spindle. Although the manufacturer exercises every possible care in packing the grinding wheels, their fragility renders

them liable to injury in transit. For this reason, every wheel should be examined by the storekeeper when received and again by the operator before mounting it on the machine.

A good method of testing a wheel for soundness is to tap it lightly with a wooden screwdriver handle or some such object. If it rings clear, it is a pretty good indication that it is sound and safe for operating. However, if a dead sound is noticed, the wheel should be carefully examined in an effort to discover any possible crack which it might have received in transit. If this precaution is taken, we feel sure that no trouble should be experienced from mounting wheels that are unsafe.

In case the wheel speed on the class of grinding performed deviates very much from that listed above, it is suggested that steps be taken to correct it. Norton grain and grade selection is based on the assumption that these recommended speeds are followed at least approximately.

Notes from the Files of Sales Engineering Department

Grinding Wheels Versus Steel Wheels in Cleaning Cast Iron Gears

Cleaning sand and metal irregularities from between the teeth of cast iron gears is an operation of considerable importance for manufacturers of certain types of machinery. In the past and at the present time in some plants, a steel wheel running at high speed is used for this work. By this method the sand is removed nicely, but the irregularities in the gear itself cannot be removed. Instead they must be filed out, and this is a slow hand operation.

A test has recently been completed in which a 12 x $\frac{1}{8}$ x 1", grain 46 Crystolon rubber wheel was used. The Crystolon wheel of course not only removed the sand,

but also ground out the metal irregularities and produced an excellently finished gear, much more satisfactory than the filed gear.

The wheel was mounted on a Norton bench machine and the speed maintained at 3,000 r. p. m., or a little more than 9,000 surface feet per minute. Four-inch flanges were used. The operator using the steel wheel received a weekly wage of \$20, whereas it was necessary with the rubber wheel to have a better and more careful man, who was paid \$22. The filers worked on a piece work basis and received four cents per 100 teeth.

In using the grinding wheel, the filing

was entirely eliminated and the operation was not as hard on the operator, inasmuch as he did not have to use as great pressure as with the steel wheel. Besides, the grinding wheel turned out over 40% more gears in a given period than could be taken care of with the steel wheel, not considering the time used for filing. The cost was reduced from 99 cents per 1,000

teeth to 48 cents, the chief saving being the expense of filing.

The cost per 1,000 teeth only included wages and cost of the grinding wheels. The steel wheel, file, and overhead expense were not considered. A very considerable additional saving would no doubt have been noted, had these been taken into consideration.

Suitable Wheels for Cutting or Slotting Glass Slabs

Considerable importance has been attached to this operation in the past two or three years, due in a large extent to the necessity for having some quick method of cutting glass blanks for lenses and prisms. Rather extensive and conclusive tests have been conducted with the result that a very satisfactory wheel has now been developed for this work.

When experimental work was first started, a rather wide range of $8 \times \frac{3}{4}$ " Alundum and Crystolon elastic wheels were used. However, it was soon found that when grinding thick slabs there was not enough clearance between the top of the glass and the bottom of the flanges holding a wheel of this diameter. To overcome this objection 10" and 12" wheels were finally adopted.

The tests were conducted on a Brown & Sharpe universal grinding machine and the wheels rotated so as to maintain a surface speed of 1,800 surface feet per minute. This speed was maintained throughout the whole test. The wheels were dressed to truth with a medium coarse Crystolon brick. After the first dressing it was not necessary to again touch the wheel with the brick.

The glass slabs were held in a vise clamped to the table of the machine. Pieces of glass less than 1" in thickness were cut off from the slab in one cut, and in cutting pieces from the thicker slabs several cuts ranging from $\frac{1}{4}$ "

deep were taken. This was done to reduce the arc of contact between the slab and wheel, a condition which can be to $\frac{1}{2}$ " eliminated by the use of larger diameters.

The grinding was performed wet to keep the glass cool and prevent it from firing and chipping. The table traverse was operated by hand and was fed about as much as the wheel could stand without stopping it. The time taken to make the cut, the wheel wear, and finish obtained were noted.

It was found that a grain 60 grade 1 Crystolon elastic wheel was by far the most satisfactory. This wheel cut free and fast, showing a little wheel wear, but leaving a good finish. It did not chip the corners to any great extent and showed no tendency to fire. The average time to make a cut through a $2\frac{1}{2} \times \frac{5}{8}$ " section was one minute per cut. In making eight cuts the wheel wore approximately $\frac{1}{8}$ " on its diameter, or $\frac{1}{4}$ " wheel wear per cut. It required nine minutes for this wheel to cut through a $3 \times 1\frac{3}{4}$ " section of Boro-silicate glass, and the wheel in this case was worn $\frac{3}{4}$ " on the diameter.

In order to keep wheels of this nature from bending and breaking under this operation it has been found that rather large flanges should be employed. Smaller flanges can be substituted as the wheel is reduced in diameter.

Interesting Tests for the Strength of Protection Hoods

Tests Conducted by Manufacturers' Committee to Determine on Specifications for Fabricated Hoods. New Safety Code

By A. ROUSSEAU

The Safety Committees of the Abrasive Wheel Manufacturers of the United States and Canada and of the National Machine Tool Builders Association after a great deal of work and study have compiled the third edition of the Safety Code which contains the most authoritative information in connection with the care and safe operation of grinding wheels. The new code is ready for distribution and will be sent on request by any of the leading grinding wheel manufacturers, all of whom endorse it.

There were several reasons for issuing the new edition, but the most important was the incompleteness in previous editions of specifications for the construction of fabricated hoods. A description of the methods used in obtaining the necessary data for compiling the specifications printed in the new edition should be interesting to "Grits and Grinds" readers.

It is practically an impossibility to calculate just how heavy a hood must be made in order to retain the pieces of



General view of apparatus used for tests

a wheel of given size revolving at a given speed. The only satisfactory way to determine if a certain hood is strong enough is to construct one and actually break a wheel in it at the prescribed speed. A large number of tests of this kind were necessary before the final figures could be determined.

Before describing the details of these tests a review of the functions of a protection hood will not be out of place. A protection hood for a grinding wheel must be strong enough to retain all parts of the wheel, in case it should break while in operation. Not only must it be strong enough to hold such pieces if the wheel is revolving at normal speed when breakage occurs, but a margin must be allowed for possible overspeed. The higher the speed at which a wheel is running, the easier it is to break it; that is, if a certain wheel, which is normally operated at a speed of 6,000 s. f. p. m. and will stand ordinary usage at this speed, should actually be run at 9,000 s. f. p. m., the same sort of treatment might be sufficient to cause breakage.

A hood which is not strong enough to retain the pieces of a wheel under these conditions is a poor safeguard, as it gives a false sense of security to the operator. For practical reasons, also, it is advisable to construct a hood sufficiently strong so that if a breakage does occur, the hood can again be used with safety. Few users would provide themselves with spare hoods and in case of a wheel breakage the old hood would undoubtedly be used again. Therefore, the hood should be strong enough to withstand the shock of a wheel breakage occurring at a reasonable overspeed without becoming materially weakened.

In conducting the test from which the data were obtained a speed of approximately 9,000 s. f. p. m. was used. It was the opinion of the committee that although conditions are occasionally found

where wheels are operated at speeds higher than this, such cases are quite rare and can be considered as abnormal. It would, therefore, be unreasonable to



First test showing failure of 5" structural channel iron on account of improper connections

require all hoods to be made sufficiently strong to retain pieces of wheels breaking at speeds higher than 9,000 s. f. p. m. The committee also believes that it would not be safe to use a speed lower than 9,000 s. f. p. m. as a basis.

The apparatus used consisted of a $1\frac{1}{2}$ " C type Norton floor stand driven by a three horsepower variable speed motor, both mounted on heavy timbers. Around one end of the machine a substantial wooden structure was built to retain any portions of the hoods or wheels which might escape from the machine. A pulley was securely clamped to the opposite end of the spindle, from which a tachometer was driven. This indicated at all times the exact speed at which the wheel was running.



Fourth test showing distortion even though heavy sections were used



Final test showing condition of properly designed hood after three breakages. Even though section is comparatively light, hood is apparently good for several more breakages

A piece of steel shafting 2" in diameter and approximately 8 feet long was suspended by chains in such a manner that it swung longitudinally, one end striking the side of the wheel near the periphery. A piece of sash cord was secured to the opposite end by means of which it was possible from a safe distance to pull the suspended shaft away from the wheel and allow it to swing back against the wheel. In some of the later tests special wheels were used which broke at a speed of approximately 9,000 s. f. m. from centrifugal force without the use of the battering ram.

In the first tests hoods of heavy cross-section, but with comparatively weak connections, were used. In the final tests hoods of comparatively light section with strong connections were used. As a result of the tests it was found that if the connections between the periph-

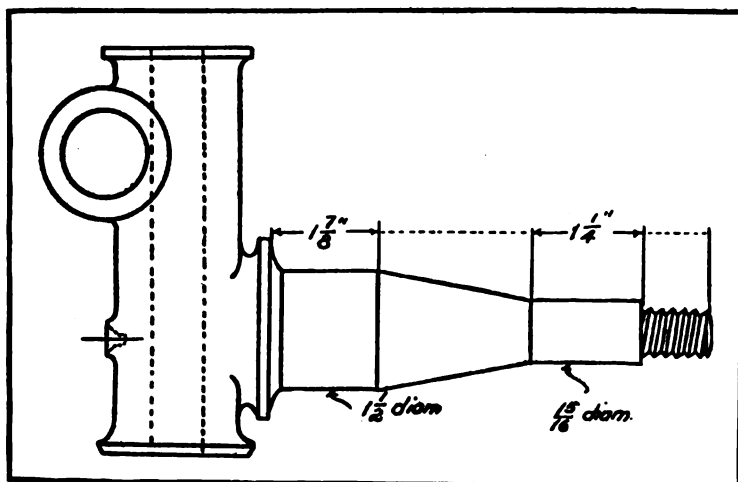
eral and side members are properly designed, the thickness of the material used in constructing the hoods need not be great. The design of the connections, however, is extremely important.

The tests proved that when a wheel breaks and the pieces fly apart the ends of the peripheral band are first to yield and considerable distortion takes place here. By the bending of the peripheral band the side plates are of necessity drawn toward each other if the connections do not give way. This causes distortion of the side plates also. On the other hand, if a rigid framework around the openings in the hood is provided, little distortion will take place and the connecting bolts and rivets in the body of the hood can be made much lighter. It was the original intention when the safety code was drawn up to give as much latitude in the design of hoods as possible,

giving the specifications for the peripheral and side members only. The tests showed, however, that these members if used alone without the stiffening framework around the opening, would necessarily be so heavy as to make their use prohibitive. Therefore, the designs il-

lustrated in the present edition of the Code are thought to be the most practical, both from the standpoint of safety and easy fabrication. We believe that from these designs hoods can be made in practically any machine shop with ordinary equipment.

Fifty Knuckles an Hour



The steering knuckle here illustrated is heat-treated steel, .015 stock removed with a .001 limit total. The machine used is a

10" x 24" Special Purpose and the wheel a 20" x 2" x 12". The production in this instance is 50 knuckles an hour.

The wheel contact helps to determine the proper grade of wheel to be used on any kind of work. On work of a small diameter there is less contact and consequently a harder grade of wheel can be used. In surface or in internal grinding the contact is very much greater so that a softer wheel gives better results.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopses of Articles Appeared in Recent Issues

914. "The eccentric head or planetary type of grinding machine, which is used so extensively for grinding the cylinders of gas and gasoline engines, may be used to advantage for many other internal grinding operations." Reeves Roll Grinder. Machinery, June, 1919, page 973. "The principal features of the Reeves roll grinder are: a cutting or grinding wheel running at regular grinding speed, which performs the grinding of the rolls or pins; a feeding wheel which rotates at slow speed and which gives both a rotary and a transverse feeding motion to the roll being ground; and a work-rest, which supports the roll on its under side while it is acted upon by the grinding wheel." This machine has been designed by M. O. Reeves and marketed by the Gardner Machine Co., Beloit, Wis.

Keller Universal Cutter and Tool Grinder. Machinery, June, 1919, page 986. This machine was developed by the Keller Mechanical Engraving Co., Brooklyn, N. Y., for use in grinding round-nosed cutters and tracers that are employed on the Keller automatic die-making machine. One of its most important features is the ability to flute cutters right out to the end.

Thompson Universal Cutter Grinding Attachment. Machinery, June, 1919, page 992. The attachment described in this article is offered by the Thompson Grinder Co., Springfield, Ohio, for use on their 10 by 36-inch universal grinding machine. It has the distinctive feature of holding a taper as well as a cylindrical arbor.

Hawes End Surface Grinding Machine. Machinery, June, 1919, page 998. Description of a two-wheel end surface grinding machine which is a recent product of C. L. Hawes, 12 Adams Street, Ashabula, Ohio. The machine is equipped with two cup-wheels which are down a pedal with one foot, the operator is able to spread the wheels apart so that the work to be ground can be placed in the fixture between the wheels; and when the operator releases the pedal, the wheels come together automatically and grind the work.

Chart for Finding Volume of Metal Removed or Area Machined in Turning or Grinding. American Machinist, May 15, 1919, page 931.

Driving Grinding Attachment of Bench Lathe with motor. American Machinist, May 15, 1919, page 953.

Sapallo for Grinding and Lapping. American Machinist, May 15, 1919, page 967.

This writer claims that pulverized sapallo and water is a good material to use for grinding or lapping in surfaces where a good joint is required.

Hardening the Job When Grinding. American Machinist, May 3, 1919, page 43E.

New Plain Precision Grinder. American Machinist, May 3, 1919, page 43E.

How to Keep Correct Shape of Saw Teeth and Grinding Wheels. Woodworker, May, 1919, page 38.

Fraser Universal Grinding Machines. American Machinist, May 22, 1919, page 1012. The Warren F. Fraser Co., Westboro, Mass., has recently placed on the market four universal grinding machines which are arranged for counter-shaft drive.

Grinding Machine for Castings. Iron Age, May 22, 1919, page 1370. This machine, manufactured by the Grand Rapids Grinding Machine Co., Grand Rapids, Mich., is intended for grinding gates, sprues, fins, etc., in the foundry and also for what might be termed the finish grinding, preparatory to filing and painting on castings where a highly finished product is demanded such as is required in the machine tool industry.

Grinding a Half-Round Concave Milling Cutter. American Machinist, May 29, 1919, page 1048.

Hand Versus Power Feed in Grinding. American Machinist, May 29, 1919, page 1052.

Barnes Precision Cutter Grinding Machine. American Machinist, May 29, 1919, page 1054. William O. Barnes, Leominster, Mass., has placed on the market a precision cutter grinding machine which is for grinding gang milling cutters.

Cylinder Grinding Applied to Special Work. Machinery, June, 1919, page 1054.

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The Important Part that Grinding Plays in the Manufacture of Tractor Parts

By W. R. MOORE

The Department of Agriculture estimates that 346,936 tractors will be produced in the United States during the present year. In 1918 the production was 132,697. At the end of 1917 there were only 15,525 tractors on hand in the United States.

This tremendous increase in tractor production results directly from the shortage of farm labor during the recent war period, when a million farmers and farm laborers were called into military service.

But not only is the tractor a valuable asset to the farmer in the solution of difficulties rising from a shortage of farm labor. It is serving many other purposes where heavy traction is required, such as logging and road making. Some of the pictures in connection with this article will give an idea of the invaluable importance which it holds in the way of increased production with time and labor saving costs.

The belt horsepower rating of various types of tractors manufactured in 1918 ranges from those of 9 to 12 horsepower up to 70 and 80 horsepower, with a few manufactured with even a larger horsepower than 80.

The story of the tractor would not be complete without a consideration of the important part the grinding wheel plays

in the manufacture of practically all its parts, for instance—gears and sprockets, tractor wheels, piston pins, pistons, reverse shafts, intermediate shafts, valve stems, chilled iron cams, washers, long and short bushings, crankshafts, cylinders, short and long pins (all kinds), radiators, levers, malleable iron shoes, link pins, cast iron and steel castings (all sizes and shapes).

In fact, practically every part of a tractor has at some time during its process of manufacture come in contact with a grinding wheel.

The accompanying table will give some idea of parts ground, size of work, machines employed on various operations, wheels used, stock removed and production. This table is of course quite general and in many cases where production is given it is only what we know has been accomplished in some plant. By employing more efficient methods of handling the work, using wider faced wheels on some operations, and possibly changing other grinding factors, the production might still be increased.

It is only about 20 years since we looked upon the automobile with a great deal of curiosity. At that time no one dreamed of an industry that would produce approximately 1,500,000 automo-



Name of part	Size	Machines Employed	Wheels Used	Stock Removed	Pieces Per Hour
Case hardened gears	3.874x2.5 hole	Heald Internal	$3\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}$, 46-K or L Alun. vit.	.015 to .030	8
	3.874x2 hole	Heald Internal	$3\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}$, 46-K or L Alun. vit.	.015 to .030	10
	3.874x4 hole	Heald Internal	$3\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}$, 46-K or L Alun. vit.	.015 to .030	5
	1.939x4 hole	Heald Internal	$3\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}$, 46-K or L Alun. vit.	.015 to .030	8
Bevel gears	4.175x2 $\frac{1}{8}$ hole	Heald Internal	$3\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}$, 46-K or L Alun. vit.	.015 to .030	5
Counter main sprocket	5.225x2 $\frac{7}{8}$ hole	Heald Internal	$3\frac{1}{2} \times 3\frac{3}{4} \times 1\frac{1}{4}$, 36-K	.020 to .030	4
Gudgeon (case hardened)	2x16 $\frac{3}{16}$	Norton 10x36	20x5, 24 C-L	.020	25
Case hardened piston pins	Two dia.	Norton & Landis	18x2 $\frac{1}{2}$, 24 C-L	.012 to .015	16
Reverse shafts	2.437x20	Norton 10x36	20x5, 24 C-L	Rough, .024 to .050 Finish, .006 to .010	Rough 18 Finish 12
Intermediate shafts	2 $\frac{3}{4}$ x23 $\frac{3}{4}$	Norton 14x50	20x5, 24 C-L	Three dia., .030	4
Chilled iron cams		Landis	24-K Crys.	.040 to .050	17
Face of thrust bearing washers	7 $\frac{1}{2}$ x.325	Landis	14x1 $\frac{1}{4}$, 36-K Alun.	.030	5
Bronze bushings	2.812x3 $\frac{11}{16}$	Norton 6x32	14x2, 36-K Crys.	.030	60
Bronze bushings	2.692x4	Norton 6x32	14x2, 36-K Crys.	.030	65
Bronze bushings	3.432x8 $\frac{13}{16}$	Norton 6x32	14x2, 46-K Crys.	.015 to .035	20
Bronze bushings	1.501x1.75	Norton 6x32	14x2, 46-L Crys.	.015 to .025	110
C. I. gear case covers		Pratt & Whitney	14x4, 24-H Crys.	.060	60
C. I. cylinders	6 $\frac{1}{2}$ x12	Heald Internal	5x $\frac{1}{2}$, 30-J Crys.	.015 to .020	25 min. ea.
Pistons	6x7	Norton & Landis	14x1 $\frac{1}{2}$, 36-K Crys.	.030 to .040	6 to 8
Chrome nickel steel crank-shaft pins	2.955x3 $\frac{13}{16}$	Norton & Landis	26x3 $\frac{9}{32}$, 36-L Alundum	.020	7 $\frac{1}{2}$ min. per pin
Piston pins (one dia.)	1 $\frac{3}{4}$ x6	Norton & Landis	18x6 $\frac{1}{2}$, 24 C-L	.015 to .020	45
Valve stems	$\frac{3}{8}$ x4	Ott grinding		.030	25
Valve stems	$\frac{5}{8}$ x6	Landis	14x1 $\frac{1}{2}$	.012	27
Shafts (chrome nickel)	Three dia., 3x36	Norton	18x2x5, 24 C-M	.030 to .040	3 $\frac{1}{2}$ per hr.



[August, 1919]



biles in 1919. This enormous production would have been a physical impossibility had it not been for the part taken by the modern grinding wheel.

The same might be said about the contemplated production of tractors. To date, this industry has taken even greater strides in the way of production than the automobile industry. The tractor, having the concentrated power of many horses without occupying much more space than one horse, is bound to meet with undivided approval on all farms.

The signing of the armistice that marked the end of hostilities and now

the signing of the peace treaty, which brings the war to a formal close, have opened the way for a vast and important use of the tractor.

Abroad, it will serve for levelling and clearing the shell-torn fields and restoring thousands of acres of war devastated countries to their former usefulness. In this country power farming is the up-to-date method of performing agricultural work. It has a very big future and the tractor promises eventually to displace older methods even more rapidly than the automobile supplanted the horse and buggy.





How Physical Properties of a Material Affect Grinding Action

By W. T. MONTAGUE

There are two things an abrasive must do in order to remove a chip—first, penetrate the metal being ground; and second, stand up to the cut while being forced through the metal.

Thus it is seen that the two physical properties of a material which affect abrasive action most are:

1. Resistance to penetration.
2. Tensile strength of the material.

High resistance to penetration and high tensile strength do not necessarily go together. To illustrate this point, consider glass which is of high resistance to penetration, but of low tensile strength; phosphor or manganese bronze which is of low resistance to penetration, but comparatively high tensile strength; white iron which is of high resistance to penetration and low tensile strength. Other similar examples might be quoted.

There are two general conclusions to be drawn from these instances just cited, namely:

1. The greater the resistance to penetration, the more brittle should be the abrasive.
2. The finer should be its size.

Of course, this article presupposes that the abrasives under discussion are infinitely harder than the materials they are called upon to cut. (We refer to mineralogical hardness.) An abrasive of a brittle temper usually fractures with sharper points and cutting edges than a tougher abrasive. Hence, there is a better opportunity for it to penetrate a hard, dense surface than a tougher abrasive would have. This perhaps partially explains why the more brittle tempered aluminous abrasive known as

No. 38 Alundum is so much better adapted for hardened tool steel than the tougher regular Alundum and why the aluminous abrasive of intermediate temper known as No. 66 Alundum is better suited to the grinding of manganese steel than either of these abrasives mentioned above.

The second factor affecting penetration is the size of the grit employed in the wheel and, generally speaking, the greater the resistance to penetration, the finer the grit should be. To illustrate this, a case may be cited where great difficulty was being experienced grinding extremely hard high speed steel. Following the usual reasoning, it was attempted with as soft and coarse a wheel as could be readily made for that particular operation, namely, a 3824-G silicate. This wheel acted hard and glazed, heating the work badly. By changing to a 3846-G silicate, a much freer cutting wheel was obtained and all trouble eliminated.

Reasoning from this and other examples of like nature, it is concluded that the finer cutting grain penetrates the metal being ground more readily than the coarser grit and although the individual chips produced might be smaller there are far more of them. In other words, on hard materials the fine wheel "bites" better than the coarse. The coarse grits seem to ride over the surface of the metal, in doing which they get dull and gradually produce a glazed face on the grinding wheel. The broader the contact, the more pronounced are these tendencies.



But the second factor mentioned earlier in our article—the tensile strength of the material—probably exerts a considerably greater effect on grinding action than resistance to penetration. An abrasive grain must be tough enough to withstand the shearing stress encountered when the grains are forced to remove chips of metal.

The metal opposes the removal of chips with a force that is proportional to its tensile strength. THE HIGHER THE TENSILE STRENGTH OF THE METAL, THE HARDER IT IS TO REMOVE A CHIP AND THE TOUGHER THE ABRASIVE MUST BE TO PREVENT FRACTURE WHILE THE GRAIN IS MAKING THE CUT. It should be brittle enough, however, to allow fracture when the edges have become dull or should be bonded soft enough so that dulled particles will be torn from the face of the wheel before they glaze and cause what is termed hard grinding action.

THIS EXPLANATION PERHAPS MAKES IT CLEAR WHY ALUNDUM IS THE TYPE OF ABRASIVE TO USE FOR GRINDING STEEL. Obviously, because of its high tensile strength and toughness, steel must be ground with a tough abrasive. The carbide of silicon abrasive, Crystolon, because of its brittleness fractures too readily in cutting to be efficient in the removal of material from high tensile strength metals. It will grind steel and high tensile strength materials, but not as efficiently as Alundum because it does not hold up long enough under the cut to do the maximum amount of work.

FOR MATERIALS OF LOW TENSILE STRENGTH, CRYSTOLON IS THE CORRECT TYPE OF ABRASIVE. This is undoubtedly true because the

resistance of low tensile strength materials to the removal of chips is far less than in the case of steel, and the brittle Crystolon grain is able to cut through without breaking off before it has done its work. Low tensile strength materials offer enough resistance to Crystolon to fracture it sufficiently to keep the wheel sharp. Because Alundum is tougher than Crystolon, the low tensile strength materials do not offer sufficient resistance to fracture it, but merely tend to dull it. Hence, the grains become worn smooth, the wheel glazes, and it is said to be not adapted to materials like cast iron, brass, aluminum, and so forth.

One way to adapt an Alundum wheel to cast iron and materials of low tensile strength is to employ less bond or, in other words, use a wheel one or two grades softer than in Crystolon. However, this is not an economical method of grinding, inasmuch as the abrasive is torn from the wheel face before it has done all the work it is capable of. That is, the wheel is kept sharp by the cutting grains being pulled out of their setting rather than by their fracturing.

There is a tendency also to use Alundum wheels for certain precision operations on so-called cast iron, especially piston rings. This may be explained by the fact that such castings usually contain a high percentage of steel which so changes the physical properties of the metal that Alundum many times cuts as well as Crystolon and finishes better. Also, the harder bronzes may be ground efficiently with Alundum wheels, especially the machine grinding operations. The tensile strength of this material is often quite as high as mild steel, which explains the tendency toward the use of an aluminous abrasive like Alundum.



Method of Supplying Lubricant to Work on Blanchard Grinding Machine

By R. M. JOHNSON

The lubrication question is highly important in grinding inasmuch as cracked, burned, and warped work probably results from excessive heating during the grinding operation. This is particularly true in the case of surface grinding machines such as the Blanchard where the arc of contact is large and the production high. Under such circumstances water should be supplied in large volume at the point where the heat is being generated and should be applied in such a manner that the work and abrasive grains which are doing the cutting may be cooled.

The Blanchard water system has been worked out along this line. As the water passes through the openings in the faceplate of the machine, it is immediately whirled by centrifugal force to the inside of the grinding wheel cylinder. As this force is about 170 times greater than the actual weight of the water, it is of a great deal more importance in determining the path of the water.

On the Blanchard grinder experiments have shown that a wheel not coated with wax inside will discharge every bit of water that can be put into it through the upper $\frac{1}{2}$ " of the wheel immediately below the retaining ring. If, however, the inside of the ring is coated with wax or paraffin, the water will cling tightly to the inside surface of the wheel in a thin sheet or film and will escape under the face of the wheel with considerable velocity, enough in fact to drive it through the spaces between the grains of abrasive when the wheel is in contact with the work. This is possible because the wax coating on the inside usually chips off about $\frac{1}{8}$ " up from the actual

cutting face of the wheel. A glance at the illustration on the following page will show the path of the water as it is thrown off the faceplate.

Considerable study has shown that the water does not distribute itself all around the inside of the wheel on the Blanchard grinder. On the other hand, when it is discharged into the annular groove in the faceplate by holes grouped at a certain point on the circumference, the maximum discharge from the lower rim of the wheel occurs along a part of the circumference bearing a certain definite angular relation to the point where the water entered the faceplate groove. The water ports are arranged to take care of this so that the water will be discharged under the wheel face in maximum quantity at the point where the maximum amount of cutting is being done. This part is, of course, along that portion of the wheel circumference, from the center of the chuck to the edge of the chuck, on the side nearest the operator, where the work is coming under the wheel for the first time.

It may seem strange that there should be this variation in discharge at the different points around the circumference, particularly when the centrifugal force appears to so far outweigh the effect of gravity; but it must be remembered that the holes in the faceplate leading from the groove to the interior of the wheel are inclined at 45° . Because of this, the centrifugal force holding the water out against the outside edges of the wheel, also causes the water to develop quite a strong downward velocity which makes it travel down along the

Much of the above material was obtained through the courtesy of the Blanchard Machine Company, Cambridge, Mass.





Norton Companies Merge

Manufacture and Sale of Norton Grinding Wheels and Norton Grinding Machines now under same Management

The business of manufacturing Norton grinding machines which has been conducted for nineteen years under the name, Norton Grinding Company, has been consolidated with the grinding wheel business of the Norton Company. The grinding machine and grinding wheel manufacture will, in the future, be connected as a single enterprise under the Norton Company.

Although some changes have taken place in the active executive offices of the Norton Company, the policies and methods will continue as heretofore. In view of the rapid development of both the grinding machine and grinding wheel business centralization of efforts will result to the mutual advantage of Norton interests and users of the products in all parts of the world.

The Norton Grinding Company was incorporated in 1900 and has been manufacturing machines for cylindrical grinding, machines for grinding plane surfaces, car wheel grinding machines, crankshaft

grinding machines, and Universal tool and cutter grinding machines.

The Norton Company was incorporated in 1885. Its business has been the manufacture of grinding wheels marketed under the trade names "Alundum" and "Crysolon," abrasive grain for polishing purposes, rubbing bricks and sticks, oil stones, refractory ware, and Alundum Tile.

There is no change in the board of directors. The sales departments are to be conducted by one sales organization with Carl F. Dietz as general sales manager; Herbert Duckworth, sales manager of the grinding wheel division, and Howard W. Dunbar, sales manager of the grinding machine division. Charles H. Norton continues as chief engineer of the grinding machine department.

This merger will even more closely effect an increased efficiency in the excellence of service which the name, "Norton," has always sought to carry with it.

Norton Store in Detroit

Large Stock of Grinding Wheels—More Efficient Service Organization

The Norton Company of Worcester, Mass., manufacturers of Alundum and Crysolon grinding wheels and other abrasive products, have announced the opening of a store in Detroit, Mich., at 73-75 West Congress Street.

With the growth of the automobile and other great industries in Michigan there has been a corresponding increase in the demand for grinding wheels, and in order to give efficient service at all times to its ever increasing number of customers the Norton Company has accordingly enlarged its Detroit organization.

In addition to carrying an ample stock of grinding wheels such as are used

in Detroit and the State of Michigan the Norton Company will expand its service organization with men of wide wheel manufacturing and operating experiences. The store and the service department are to be managed by C. W. Jinnette, who has been the Norton Company's district manager in Detroit for a number of years. The sales and demonstrating forces will consist of W. T. Cushing, Waldo E. Whiting, Lucien Gay, and Dean Wheatley, all of whom have had a special training course at the Worcester plant and experience in laboratory and sales work. This organization will be backed by special demonstrators from the Worcester factory.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

Grinder for Drills. *Iron Age*, June 5, 1919, page 1517. A drill grinder that is automatic in the actual grinding of the drill lip. This machine is marketed by the Bellevue Industrial Furnace Co., Detroit, Mich.

A Patriarch Among Grinding Machines. *American Machinist*, June 5, 1919, page 1096.

New Rotary Surface Grinders. *Iron Age*, June 12, 1919, page 1586. This grinding machine is manufactured in two sizes with an 8-inch and 12-inch chuck, by the Heald Machine Co., Worcester, Mass.

Turning Versus Grinding. *American Machinist*, June 12, 1919, page 1154.

Grinding a Large Die Without Equipment. *American Machinist*, June 12, 1919, page 1154.

Newton Radius-Link Grinding Machine. *American Machinist*, June 12, 1919, page 1155. A detailed description of a grinding machine manufactured by the Newton Machine Tool Works, Inc., 23rd and Vine Streets, Philadelphia, Pa. This machine is intended for railroad-shop use.

The Abrasion-Meter; a Device for Determining the Cutting Efficiency of Abrasive Wheels. *Scientific American Supplement*, June 14, 1919, page 372. A description of an abrasive testing machine constructed by R. F. Yates, who has plotted some interesting

curves with this device and has made a formula by means of which he claims that the abrasive efficiency of various wheels may be stated in actual figures.

Methods for Grinding Patternmaker's Tools. *Foundry*, June 15, 1919, page 403. An explanation of the reason why it is considered good practice to grind an edge tool on a wheel revolving towards the operator and a discussion of factors which sometimes make this method impracticable.

Planer Speeds—Knife Grinding. *Woodworker*, June, 1919, page 47.

Finishing Operations on Liberty Motor Cylinders. *American Machinist*, June 19, 1919, page 1197. Two rough grinding and two finish grinding operations are given in these notes.

Grinding Attachments for the Potter Precision Bench Lathe. *American Machinist*, June 19, 1919, page 1205. These attachments are made by the S. A. Potter Machine & Tool Works, 79 East 130th Street, New York, N. Y., and can be used on any lathe provided with a drum countershaft for driving them. They are intended to be used on the slide rest and are provided with rockers to allow vertical adjustment.

Vital Points in the Manufacture of Files. *Iron Age*, June 19, 1919, page 1631. A discussion of the steels used and the operations of annealing, grinding and cutting in the manufacture of files.

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The Vital Necessity of Having Wheels for Cylindrical Grinding in Balance

By JOHN N. PECKHAM

During thirty years' development in grinding machines, the engineers have spent almost unlimited time and money to perfect those of the present time. They have realized and tried to impress upon their customers, also the makers of grinding wheels, that if the machine is to be a success, the grinding wheel must be in balance.

An out-of-balance wheel causes chatter marks on the work, causes the wheel to pound and wear unevenly, and breaks up the wheel face. An out-of-balance wheel calls for frequent dressing or truing with the diamond, with the result that the diamond cost and wheel wastage are excessive.

For example—an 18" diameter wheel one ounce out of balance, running 1,360 r. p. m. on a 10 x 36" Norton cylindrical machine, exerts force of about 25 pounds and will produce vibration in the machine. This vibration is reproduced on the work. The continual pounding in the spindle boxes will, in time, wear the boxes and spindle egg-shaped. With these conditions existing, not only is unsatisfactory work produced, but the ultimate destruction of spindle boxes also is a certainty.

Although the most adequate safety hoods and guards are provided, the greater possibility of breakage of an out of

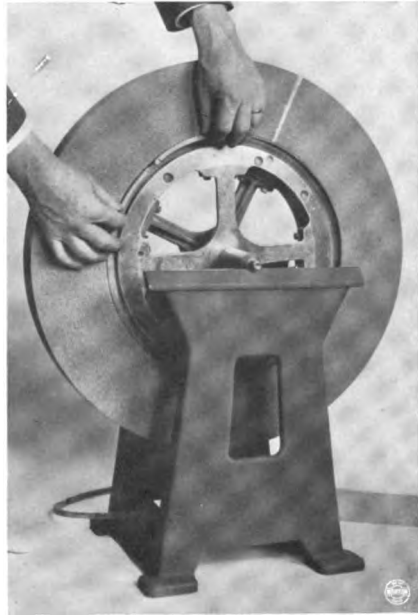


Balancing a Grinding Wheel by Means of a Specially Designed Iron Center

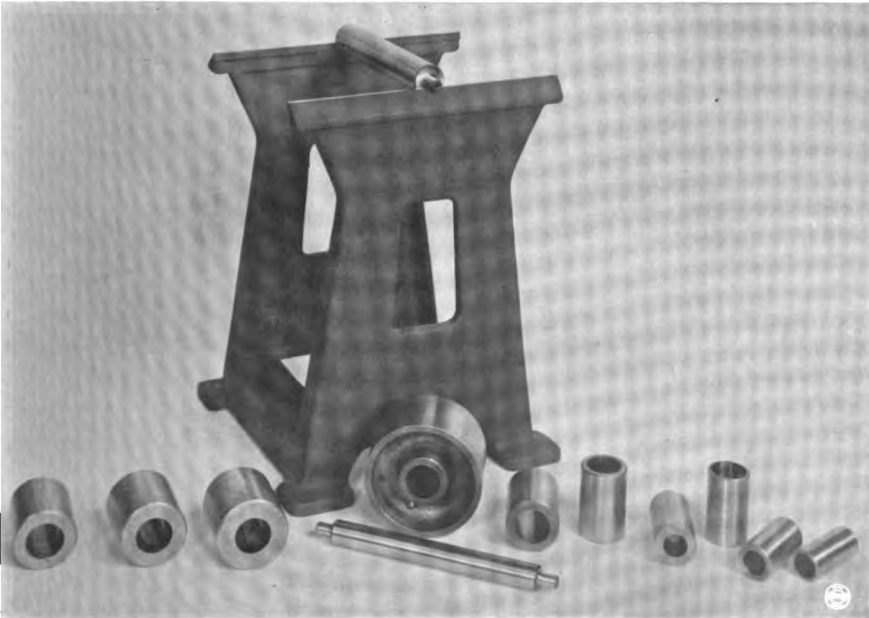
balance wheel endangers the operator and nearby fellow-workmen. With all evils mentioned heretofore, this one alone should be considered first—the protection of life and limb.

Users have, in many instances, believed the gears in the headstock, or lack of good bearing in spindle boxes, caused chatter marks, but in practice nine cases out of every ten have proved the wheel was out of balance. The wheel does not appear to be given consideration by many users as a part of the equipment which makes up the grinding machine. Very seldom any thought is given to wheel balance. It stands to reason that the original lead used to put the wheel in balance will not maintain that balance as the diameter is reduced by wear.

For example—an 18 x 2 x 5" wheel in perfect balance, reduced to 14" or 15" in diameter, has been found to be out of balance several ounces.



How Balancing Bands are used for Balancing Wheels with a Countersink



Norton Balancing Ways and Equipment of Arbors and Bushings

[SEPTEMBER, 1919]

[3]



Never tighten spindle boxes to overcome chatter marks. The procedure may help the condition, but it will never eliminate it. Put the grinding wheel in static balance from time to time.

A wheel in balance at all times reduces the diamond consumption and wheel wear beyond expectation, and the user of

grinding machines and wheels will secure four important results.

First—Safety for the operator.

Second—Good work.

Third—Accuracy.

Fourth—Production.

The time employed in balancing wheels will save many dollars' worth of diamonds, wheels, and machine repairs.

Sizing Work on the Blanchard Surface Grinding Machine

Comments on Gaging by Color — The Blanchard Method of Sizing

An article published in the June issue of *Grits and Grinds*, "Gaging by Color the Work on the Surface Grinder," has brought us a number of communications on the subject calling attention to the fact that this is not a new method, but rather an old one. Among the several very interesting communications is one from The Blanchard Machine Company commenting as follows:

"It is a good method, but we prefer the continuous reading caliper attachment on our machines which is not as delicate a device as one might think from reading the article in question.

"It is usually possible to so position the caliper with reference to the work that the contact shoe rides on a practically continuous surface. Of course if the work is very broken or narrow in surface it is necessary to either slow down the chuck speed momentarily or stop the chuck for taking the reading. Even in that case the caliper is much faster than micrometers and has the advantage over the colored block that the caliper will indicate how much more stock is to be removed at any point in the grinding operation, whereas the color block is merely a limit indicator and gives no indication or practically none until the finished size is reached."

The following description of the Blanchard method of sizing work on the Blanchard surface grinder submitted with the comments will be found valuable to readers who are interested in this subject

The Blanchard Method

The measurement of work thickness with micrometers or a snap gage is usually not necessary in production work except as a final check after the work has been removed from the machine. There are three common appliances used for grinding to a definite thickness without stopping and removing a piece for measuring. These are

1. The Blanchard caliper attachment.
2. The graduated feed wheel and stop.
3. A coppered or painted size block on chuck.

Each has its advantages and defects and the choice between these methods depends on the kind of work.

1. The Blanchard continuous reading caliper.

This attachment measures the work while it is in place on the chuck and being ground. The dial is set to zero with contact button resting on a size block or finished piece of work. When set in this

way the caliper will indicate in thousandths of an inch the amount by which pieces passing under the contact button exceed finished size, and will read zero when finished size is reached. On most work the reading can be taken without stopping the chuck and without in any way interrupting the grinding.

The usual way is to swing the caliper onto the work just before finished size is reached and let it ride on the work until the needle of the gage gets within .001" or .002" of the 0 mark, then stop the feed, and let the chuck run a few revolutions without feed to smooth the surface of the work. This will take off a little more metal and leave the size correct as indicated by the needle of the indicator standing at zero.

If the surface of the work is narrow and broken the indicator needle will of course vibrate more or less, and if it does not dwell long enough to permit a reading it will be necessary to slow down or stop the rotation of the chuck long enough to get a reading.

The caliper can be depended on for working to limits of $\pm .001''$.

It is not recommended for very narrow surfaces nor for work where very little stock is removed (hardened ball races, etc.) as such work can usually be sized by working from the graduations of the feed wheel as follows:

2. The graduated feed wheel and stop.

The feed wheels of all Blanchard grinders are graduated in thousandths of an inch. About $\frac{1}{2}''$ on the rim of the feed wheel (5 teeth or 1 graduation) corresponds to .001" vertical movement of wheel head.

Suppose a load of work has been ground to size, as determined by removing a piece from the chuck and measuring it with micrometers or a gage and that the stop shield on feed wheel was set,

before raising the wheel from the work, so that its edge agreed with the reference line or pointer; the next lot of work can then be ground down to that point and will be oversize only by the amount worn off the wheel. Before removing this load from the chuck, measure a piece with the micrometer and set the stop shield back by the amount the piece is oversize and grind down to the new stop position.

By doing this on a few chuck loads of pieces the operator soon learns the average wheel wear per load and can set back the stop shield that amount for each load. After a load is removed and the machine started grinding on the next load, one of the pieces just removed can be micrometered and if slightly larger or smaller than exact size (but within limits) the stop shield can be set back or forward as the case may be. In this way work can be held close to size without any interruption of the grinding operation for the purpose of measuring.

The closeness of limits possible by this method depends on the amount and uniformity of the wheel wear. With moderately hard and fine wheels suitable for narrow surfaces (for example 30 I) the wear per load will be extremely small and work can be easily held to limits of $\pm .0005''$ and an experienced operator can work to $\pm .00025''$.

3. A coppered or painted size block on chuck.

This method consists in coating with copper or paint the upper surface of a piece of work or block of correct thickness which is placed on the chuck among the pieces being ground. The cleaning of the surface of this piece when the wheel touches it indicates to the operator that finished size has been reached.

This method is independent of wheel wear and applicable to work ground from the rough where the large and variable

It has the disadvantage of requiring the undivided attention of the operator and offers no clear indication of how near

work is to size except that in some cases chips will adhere to the block and when these are brushed away by the wheel the operator knows that the work is approaching size.

[The following article is reprinted from the Machine-Tool Review, published by Alfred Herbert, Ltd. of Coventry, England. The writer of the article gives his ideas of grinding twist drill bodies on a Norton Machine and advances some useful information about suitable grinding wheels, speeds, feeds, order of operations, production times, and a few necessary fittings to the job.]

For grinding the fluted parallel of taper shank drills of the whole lengths when the drill is parallel throughout, the most suitable wheels are Norton, grain 60, grades N to P. For grinding shanks, taper or otherwise, in a plunging cut with wheels fully as broad as the shank is long, the most suitable wheels are Norton, grain 46, grade L, or grain 24, grade C. L.

The grinding wheels should be run at a surface speed of 6,000 to 6,500 feet per minute for both traversing and plunging cut grinding. The work piece in traverse grinding should be revolved at a surface speed of 60 to 80 feet per minute and for plunging cuts at 40 to 60 feet per minute.

For drills up to $\frac{3}{8}$ " diameter, 3" x 18" Norton machine; $\frac{3}{8}$ " to $1\frac{1}{4}$ " diameter, 6" x 32" machine; $1\frac{1}{8}$ " diameter and upwards, 10" x 36" machine. For grinding shanks, taper or parallel, in a plunging cut with wide or "formed" wheel, the 6" x 32" machine may be used, if the shank is under 4" in length, but the best results are obtained in form grinding with the Norton 10" x 24" special purpose machine. The fluted portion should be ground by the traversing method only.

A special driver is necessary so that the peg will enter the flute of the drill and

leave the round surface clear for the grinding wheel. Figure 1 shows a simple and effective design which may be attached to the driving plate where a running center is used. If the drill is very small, the driver may be modified for attachment to the running center. Where a dead

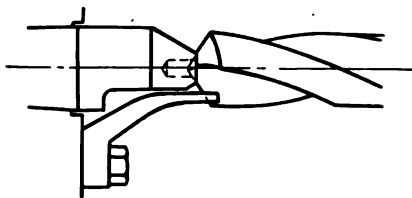


Fig. 1. Driver for Twist Drills leaving full length clearance for Grinding Wheel

center is used a slight modification would enable it to clear the center. When the fluted end is ground as a separate operation the ordinary carrier is fixed on the shank end.

The drills should not have less than .005" to .008" left on the diameter for grinding, after previous machining operations are completed.

Drills up to $\frac{3}{8}$ " diameter may be classed as small, and generally have straight shanks parallel with the fluted portion. Those as small as $\frac{1}{16}$ " and under should be ground with a running spindle attachment. The full length is ground at one operation.



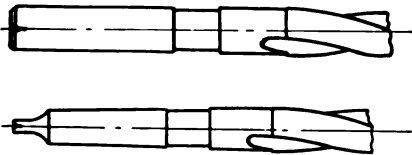
at the rate of about 60 an hour, but very small drills take longer, owing to the inconvenience of handling them.

Many small drills are made with a slight taper on the fluted portion, the cutting end being the largest. Two operations are necessary with these, and each operation will take practically the same time as grinding the whole drill parallel. Grind the fluted part first.

Medium and Large Drills

These are generally made in three forms—with round shank parallel with fluted portion as in figure 2, with taper shank as in figure 3, or with tapered square shank for ratchet or brace use.

It is usual to have a recess in both the forms shown in figures 2 and 3 and a slightly reduced portion from about the end of the flutes to the recess. There should also be a slightly reduced part in square shank drills. These parts need not be ground; the size of the drill is stamped on one of them, preferably on the smallest, or on one of the flats of the square shank.



Twist Drill Shanks showing recessed and reduced parts. Fig. 2, Parallel; Fig. 3, Taper

In grinding any of these put the carrier on the shank end. After putting the drill in the grinding machine centers, set the left hand reversing dog so that the reversing lever is over solid to the right when the corner of the wheel is over the center of the recess. If there is no recess and the shank shoulder is larger than the drill the wheel should just touch the shoulder. Then set the right hand reversing dog so that the table will reverse when the wheel overlaps the job by about an inch.

On starting grinding bring the wheel forward to left hand end, as already defined, and feed straight in to plus .002" of the required size. Put traverse belt and lever over for the second lowest table speed possible and put in traverse lever, thus removing all but .002" in one cut. The production rate for this cut should be 27" of length per minute on a 6" x 32" machine and 22" on a 10" x 36" machine.

Immediately this cut has been completed, swing over the two-speed traverse lever (on the front of the machine) and finish to size in cuts of .0005" per traverse. The automatic feed pawl link should be

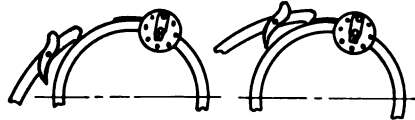


Fig. 4 (left). Position of automatic feed pawl for first cut and slow traverse

Fig. 5 (right). Auto-feed and traverse; at above position Drill is ground to size

set on the quadrant to give a feed of two notches (.0005") on each reversal of the table. The carrier can be put on the next drill while the machine is automatically making the finishing cuts. The actual grinding times for grinding the fluted parts of $\frac{3}{4}$ " drills of $6\frac{1}{2}$ " standard length is 30 seconds and $1\frac{1}{4}$ " diameter 9" standard length 40 seconds, both on the 6" x 32" machine. These times allow for removing up to .010" to .015" from the diameters. The positions of the automatic feed pawl are shown in figures 4 and 5.

Grinding Shanks

The shanks, parallel or taper, are most economically ground in one plunging cut on a Norton S. P. machine. A wide wheel is used, parallel or formed to the taper. The actual grinding time on, for example, a No. 3 Morse taper shank or parallel shank of about the same length is 30 seconds for removing up to .015" from the diameter.

It is very often necessary to grind taper shanks in two operations on account of the slight distortion that occurs on some steels after grinding. This distortion is so slight that it is not appreciable on a parallel unless the gaging hole is very long, when a slight binding would be felt. It is more easily felt on a taper gage. If it is found that the steel has this tendency, and two operations are necessary, reduce to .003" above size at first operation. Lay the drills aside for at least 12 hours and then finish to size as a second operation.

Variation in Lengths

Where the drills as received for grinding are not exactly the same length a quick means of adjustment must be found, so that the shank may be ground at the correct distance from the shoulder.

Figure 6 shows a fitting which has been found successful and sufficient. A spring center is fitted as shown, and a setting piece is fixed to locate the shoulder. If adjustment is necessary, slack the spring center clamp, with the work piece between

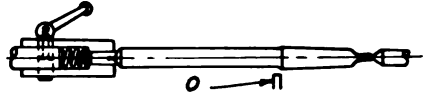
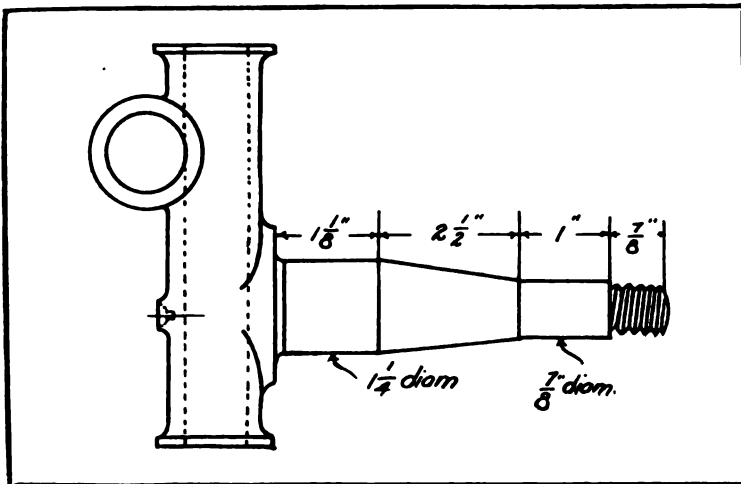


Fig. 6. Spring Center and fixed Setting Piece O to locate shoulder for Grinding the Shank. (Carrier omitted, see Fig. 1)

the centers, and adjust the shoulder to the setting piece by the tailstock screw. Then tighten the spring center clamp and adjust the tailstock center for running.

If good methods are followed throughout, it is not difficult to grind twist drills to fine accuracy and in quick time.

Sixty Steering Knuckles an Hour



Sixty steering knuckles an hour is production well worth mentioning. This is not unusual, however, for the grinding man who is using Norton wheels on a Norton Grinding Company machine. This sketch

is a diagrammed possibility. The knuckle is heat-treated steel, .040 stock removed with .001 limit. The machine used is a 10" x 24" Special Purpose running a 20 x 2 x 2" Norton wheel.



Notes from the Files of Sales Engineering Department

KNIFE GRINDING

There are of course a large number of different kinds of knives: paper, planer, chipper, barker, leather splitting and so on.

These types of knives can be ground in a satisfactory manner on any of the popular knife grinders. Norton wheels have been very satisfactory for grinding both hardened carbon steel knives and also high speed steel knives. It must be understood that in being guided by these recommendations consideration should be given to local conditions which may affect to a great extent the wheels which should be used for any operation. For instance, very hard knives may make the use of a slightly softer wheel necessary, whereas somewhat softer knives than the average will allow the use of a somewhat harder wheel.

Wheels Used

Generally speaking a 6630 or 6636 I or J silicate wheel will be found satisfactory when a cup wheel is used, while for straight or disc wheels it is necessary to go a little harder to 6636 J or K silicate.

Wet Versus Dry Grinding

When hardened carbon steel or tempered carbon steel knives are being ground, we recommend most strongly that a copious supply of lubricant be used during the grinding. This is primarily to keep the knife from heating excessively and having the temper drawn, but also to keep the temperature uniform so that the temper will remain the same throughout the length of the knife. Knives can be ground dry, but it is dangerous unless a great deal of time is taken. It is therefore a poor production operation. High speed steel knives should be ground dry unless a very large amount of lubricant is used. This is because rapid changes in temperature of high speed steel are very liable to result in cracking. A small stream of water running on the knife is much worse than none at all.

Lubricant

There are several very satisfactory grinding compounds on the market at

present. Also if desired, a very satisfactory lubricant can be made by adding one gallon of lard oil to 40 gallons of water. To keep the machine from rusting five pounds of sodium carbonate should be added. Care should be taken that too much lubricant is not used as it will result in the wheel face becoming gummed up. The wheel will then glaze badly and cut very slowly, which is of course exactly the opposite result from that obtained when the proper amount of compound is used.

Some sort of grinding compound is desirable because:

1. The power necessary to grind is somewhat reduced.
2. The wheel face is kept in better condition, reducing the amount of dressing necessary.
3. Because of this the wheel life is lengthened.
4. Rusting of the machine and knives is eliminated.

Cup Versus Straight Wheels

In knife grinding there seem two good reasons why cup wheels should be used instead of straight or disc wheels. They are:

1. The wheel speed remains constant throughout the life of the wheel.
2. Too much concavity will weaken the edge of any kind of a knife. In the case of chipper and barker knives, both types of which are subjected to a very severe strain during use, they should have a maximum strength at the edge. Because of this most operators prefer a straight bevel which can be obtained by grinding the knives with a cup wheel.

Wheel Speeds

For knife grinding wheels we recommend a surface speed of from 3,500 to 4,500 s. f. p. m. This should of course remain as nearly constant throughout the life of the wheel as possible. With cup wheels we do not have to worry about the



speed changing as the grinding is done on the rim of the wheel, the diameter remaining constant until the wheel is worn to a flat disc.

With disc or straight wheels, however, the speed must be changed constantly to keep it up to the proper operating speed. We would recommend that when a straight wheel is mounted the revolutions be so adjusted that a surface speed of 4,500 feet per minute can be obtained. Then as the wheel wears down the speed will be reduced until finally the lower recommended speed of 3,500 feet per minute is reached. At this point the revolutions should be increased so that a surface speed of 4,500 feet per minute can be reached again.

Machines

Any knife grinding machine should be set upon a good solid concrete foundation so that it will be practically free from vibration. To obtain a satisfactory edge on knives there must be a minimum of vibration in the wheel. Besides a solid foundation, the wheel should be trued every once in a while to clean off the glazed surface and renew the cutting face as well as to keep the wheel in perfect truth. Also the wheel should be kept in good balance to eliminate this cause of vibration.

Of course as in the case of any type machine, it should be kept clean and well oiled. The bearings and belts should be kept in satisfactory condition at all times.

The Testimonial of an English Foreman

I am foreman of the Grinding department of Messrs. Peter Brotherhoods, Ltd., Peterboro, and get much useful information from the monthly, "Grits and Grinds," which you are good enough to send me. I thought that perhaps the following data which have come under my notice after careful supervision would be of interest to you.

Among my machines I have a 10" x 36" self-contained, motor driven, plain Norton grinding machine, which takes a 20" x 5" wheel. I had occasion to do a great deal of repetition work on this machine, so I carefully watched the action of a wheel which I mounted on it.

The parts to be ground were tapered rollers of 40-ton steel $3\frac{1}{2}" \times 2\frac{1}{2}" \times 4\frac{1}{2}"$, turned on a Gridley automatic machine leaving stock to the extent of about .025 to be removed, and gun-metal pins, $1\frac{1}{8}" \times 5"$, leaving stock to the extent of $\frac{1}{16}"$ to be removed. The wheel was a 20" x 5" x $12\frac{1}{2}"$ hole with 15" recess for plates of arbor, grain 3824, grade L. This wheel was mounted on February 2, 1918, and taken off as worn out on July 15, 1918. The diameter then was $15\frac{1}{2}"$, thereby leaving only $\frac{1}{4}"$ of wheel either side when it began to break away (see sketches). With a variable-speed motor, 6,000 feet surface speed was maintained throughout the life of the wheel.

The waste was taken from the tank each week and dried, after which it was weighed. The total weight of metal

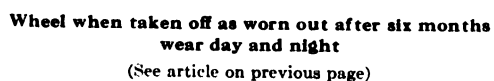
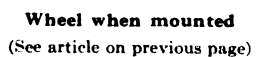
removed during this time was 1,905 pounds.

You will note from this that for the wear of a $2\frac{1}{4}" \times 5"$ or a $4\frac{1}{2}"$ diameter x 5" face wheel nearly one ton of stock was removed in just a little more than six months. The finish limit of the steel rollers was $\pm .00025$ and the production about 48 per hour. The finish limits of the hard gun-metal pins was $\pm .001$ and the production about 60 to 70 per hour.

I trust these data will be acceptable to you. I have many of your machines and also others on which I always advocate the use of Alundum and Crystolon wheels. I find them the best both in production and in the variety of work which they will do.

According to the above figures a total of 625 cubic inches of abrasive was used in removing one ton of stock consisting of soft steel and hard gun metal. This means that 3.2 pounds of metal were removed per cubic inch of abrasive; or, in the terms more commonly used, 11.3 cubic inches of steel per cubic inch of abrasive. This is on the basis that all the material was soft steel.

While these figures are not far different from other figures obtained here, still the removal of material is a little higher per cubic inch of abrasive than would ordinarily be expected with such high production per hour. The whole performance speaks well for the methods used and the supervision.





Abstracts from Current Articles Pertaining to Grinding

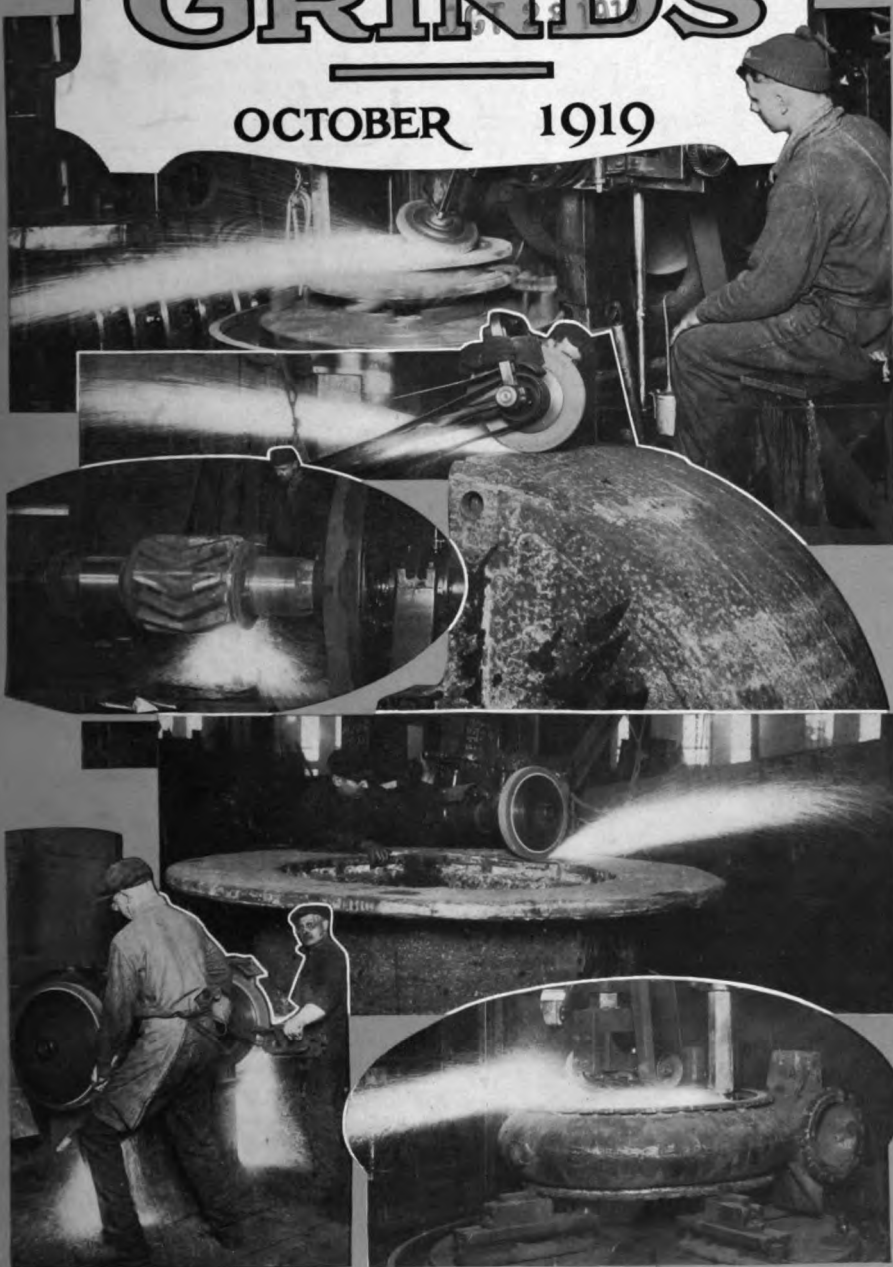
Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

- Latest Practice in Cutter Grinding.** American Machinist, July 17, 1919, page 135. This is the first of a series of articles that presents the latest practice in cutter grinding, as recommended by the Cincinnati Milling Machine Co.
- Brooks Tool-Grinding Block.** American Machinist, July 17, 1919, page 145. Description of a recent product of W. C. Brooks, 1052 State Street, Springfield, Mass.
- Improving the Knife Grinder.** Woodworker, July, 1919, page 30. The writer had found that when the travel on the knife grinder was reversed, the long planer knives were not ground perfectly straight and there was not the same bevel on every knife. He tells how he overcame the difficulty.
- Testing Machines for Grading Abrasive Wheels.** American Machinist, July 24, 1919, page 177. The author of this article tells about two machines which have been developed lately to determine the cutting properties of abrasive wheels and their degree of hardness.
- Ross Tools for Truing Grinding Wheels.** American Machinist, July 24, 1919, page 181. Detailed description of a grinding-wheel truing tool which has been developed recently by the Ross Mfg. Co., Cleveland, Ohio, who consider it on a par with diamonds for truing straight-faced grinding wheels.
- Latest Practice in Cutter Grinding.** American Machinist, July 24, 1919, page 185. This article describes the grinding of modern shank and shell end mills, large face mills, side milling cutters and staggered-tooth slotting cutters. A method of relieving the tooth-corners of high-duty face mills is described.
- Precision Cutter Grinder.** Automotive Industries, July 31, 1919, page 219. Description of a machine made by Russell, Oldbrooks & Henderson, Inc. This grinder makes possible the use of profile ground form cutters, which are claimed to be superior to the form relieved type, as regards quality and quantity of work produced. A truing device and a cutter jig are furnished.
- Disk Grinder with Lever Feed.** Iron Age, August 7, 1919, page 364. Description of a single spindle disk grinder manufactured by the Badger Tool Co., Beloit, Wis. The features emphasized are the level feed work table, ball bearing spindle mounting, and the rockershaft construction.
- Latest Practice in Cutter Grinding—III.** American Machinist, August 7, 1919, page 251. Angular cutter grinding and the grinding of formed cutters as well as the grinding of taps are discussed in this article.
- Haskins Die-Sinker's Grinding Outfit.** American Machinist, August 7, 1919, page 288. A flexible-shaft grinding outfit intended for die sinking or other work where it is desired to obtain a good finish in pockets or recesses has been developed by the R. G. Haskins Co., 547 West Washington Building, Chicago, Ill.
- St. Louis Grinding Stands.** American Machinist, August 7, 1919, page 288. A new line of floor type grinding stands has just been placed on the market by the St. Louis Machine Tool Co., 932 Loughborough Avenue, St. Louis, Mo.

In wet grinding the stream of water should be applied at the right spot, which is the grinding point. It should have sufficient force to keep the face of the wheel clean while in contact with the work.

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FOUNDRY GRINDING



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A Grinding Wheel Record System for the Foundry

By R. M. JOHNSON

In the cleaning room of a foundry, especially where steel and malleable iron castings are made, large quantities of grinding wheels are used. The cost of grinding is therefore an important item and considerable time can well be spent in studying the grinding conditions in order to determine the most efficient grinding wheel to be used as well as the best conditions under which it should be used. No conclusive nor even valuable study can be made of this problem unless proper records are kept. Because local conditions have such a great effect on the results obtained, it is important that this record should be kept as a permanent source of information to immediately bring to light any variation from the standard practice.

The installation and use of a satisfactory system meeting all the requirements is not a difficult undertaking. When the whole system is in smooth running order, very little work is necessary in tabulating the figures and making out whatever reports may be desired. The following is a brief explanation of the figures which should be kept and the reports which can and should be obtained from them.

Record Cards

Whenever a wheel is given out from the stock room, a card is issued to the grinding

foreman. He should enter on each card:

1. The Norton order number
2. The machine number
3. The date and time the wheel is mounted
4. The date and time the wheel is taken off
5. The diameter of the wheel when taken off
6. Tonnage of castings ground (where a standard part is ground the number of pieces should also be noted)

From these figures the life of each wheel can be calculated, its total production, production per unit of time, production per cubic inch of wheel wear, and the important figure—the total grinding cost. These figures should be calculated on the cards. (The figure at the top of the next page shows a card which may be used).

The figures should be transferred to a permanent record book in which they may be classified by operators. Such a method will show what each operator is doing every month. In addition there should be one sheet showing the figures for all wheels used each month. If a sheet similar to the one shown in the illustration is used, a comparison can be obtained easily for the twelve months in the year for each operator and on a summary sheet for the whole cleaning room, or in any other way desired.



GRINDING WHEEL RECORD CARD

Norton Order Number.....
Wheel Specifications.....
Machine Number.....
Operator's Number.....
Date on..... Time.....
Date off..... Time.....
Total life..... Hours..... Min.....
Final diameter..... Inches.....
Wheel wear..... Cu. In.....
Tonnage ground..... Lbs.....
Tonnage per hour..... Lbs.....
Tonnage per cu. in wheel wear..... Lbs.....
Total grinding cost per ton of castings..... \$.....

Advantages of a Record System

Possibly the enumeration of a few advantages of a complete record keeping system will show at a glance just why this is an asset for any foundry. We can determine

1. Total grinding cost
2. Variation in production of the different operators
3. Variation in production of the different machines
4. Variation in production of the different wheels
5. How new test wheels compare with those regularly used
6. A proper piece rate for the grinders.

Total Grinding Cost

This figure should include besides the wheel and labor cost, an item which is often forgotten—overhead charges. Overhead charges are calculated either for each machine or for each man. From figures we have had given us at several plants it seems reasonable to assume that for a swing frame grinding machine the overhead is calculated as at least \$1.00 per hour, and the wheel cost amounts only to approximately \$.20 per hour or one-fifth of the overhead. It can easily be figured that with labor at \$.50 per hour an increase in production of 10% is as important in affecting final wheel cost as

SHEET FROM GRINDING WHEEL RECORD BOOK

Operator No. _____

Year.....

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. of wheels used												
Tonnage in lbs. per hour												
Tonnage in lbs. per cu. in wheel wear												
Total cost per ton												



an increase of 100% in wheel life, assuming that the production in the case of the increased wheel life would remain constant. As a matter of fact it would not remain constant and the cost would be even greater, due to the higher overhead per ton of castings ground.

It is, therefore, much more desirable to endeavor to increase the production per hour at the expense of wheel life than to try to increase wheel life at the expense of production. Of course there is a limit softer than which it would be impossible to go. We have had cases where we have changed from a grade W to a grade R wheel, a change of 5 grades. An added advantage of the softer wheel is the fact that the grinders do not have to work as hard as with harder wheels.

Variation in Production Per Operator

Usually grinding operators do considerable complaining about wheels being too hard. In a great many cases this condition is due to imagination or to a desire to get softer wheels which are easier to grind on. By classifying the results the operator has obtained with the same wheel in the past, one can easily determine whether the wheel that is being tested is hard or not. If the tonnage per hour has not decreased, it can safely be said that the wheel is cutting satisfactorily.

Variation in Production Per Machine

An operator may be changed to a new machine and immediately complain that the wheel does not cut. By tabulating the results obtained on that machine it may be possible to find that no matter what operator has used this particular machine, the production has always been low. Examination of the machine will probably show that the wheel speed is either very much too low or too high or the bearings are in such condition that the vibration is excessive.

Variation in Production Among Different Wheels

From the records which we suggest here, a variation in a shipment of wheels from the standard can be clearly shown and just what the trouble is—whether too soft, too hard, too short life, or any other trouble which may arise.

Test Wheels

It is of course of advantage if test wheels can be compared on a sound basis with the regular wheels, for it happens frequently that slightly changed conditions may make it necessary to use slightly different wheels. With past records to compare new records with, it is much simpler to determine accurately how much better or poorer the new wheels are than the old ones.

Every grinding wheel used at all regularly should have an exhaust hood and should be connected to an exhaust system supplied with a suitable fan.

ROLLING MANGANESE STEEL

In the article on "Grinding of Manganese Steel" which appeared in the June issue of "Grits and Grinds" was the following statement referring to steel containing from 12 to 14 per cent manganese—"As it is impossible to roll such steel, all parts must be cast." We have since learned that the Edgar Allen & Co., Ltd., of Sheffield, England, are rolling such steel in their plants. The process used is their own and is covered by patents to which they have sole rights in the United Kingdom and Europe.



Norton Floor and Bench Stands for the Foundry

Floor and bench stands which are to be used for snagging castings in the foundry must be so designed as to be readily adapted for handling a great variety of work economically. They must be so well made that the hard usage of the foundry will not result in a high yearly depreciation. They must be of such quality as to be available for use each day instead of being constantly down for repairs and they must be safe to operate.

The Norton Model D floor and bench stands were designed with these thoughts in mind. Rather than develop a machine considering first cost alone, proper attention was paid to those characteristics which would make the machines a desirable addition to any cleaning room where production and low up-keep are of first importance.

Rigidity

Long experience has shown that the most important factor in obtaining maximum production, efficiency and safety in any snagging operation is the rigidity of the machine. The base castings must be large and heavy enough to absorb a great amount of vibration caused by wheels becoming out of round during grinding and pounding the work against the wheel. Elimination or reduction of the vibration gives longer life to the machine, lessens the amount of repairing and adds to the safety factor. The illustration of the Model D floor stand shows the massive construction of this type. The $1\frac{3}{4}$ " spindle machine mounting a wheel $20 \times 3\frac{1}{2} \times 1\frac{3}{4}$ " weighs 1200 pounds compared with other machines on the market mounting the same size wheel which weigh from 500 to 600 pounds. There is of course a difference

in price, but the comparative weights indicate the reason.

Bearings

Closely allied to the rigidity of the machine in helping keep down the vibration is the bearing design. Because of the weight and rigidity of this type of stand, it is possible to use a very desirable overhang in the bearing design. The resultant long bearing surface insures a long life and low upkeep. The bearings and oil chambers are completely enclosed in dust proof covers.

Positive lubrication is obtained by mechanically distributing oil over the bearing surfaces. The oil reservoir under and between the two parts of the bearing hold a supply of oil sufficient for several months. Ample space is allowed for the oil to drain back into the reservoir and be used over and over again. The reservoir can be easily emptied and cleaned before putting in a new supply of oil.

Floor Arrangement

Many floor stands are so designed that the base occupies a considerable amount of floor space. This many times interferes with the grinder giving him an insufficient amount of foot room, making it necessary for him to bend over constantly while grinding, a very tiring position.

Looking at the Model D floor stand you will notice immediately the adequate foot room under the work rest. This is made possible by the long overhanging bearings which in turn are made possible by the rigid machine construction.

Distance Between Wheels

To be able to handle long castings efficiently so that both grinders can be working together at all times, there must

be ample distance between wheels. The 13 $\frac{3}{4}$ " floor stand has a distance of 54-5 $\frac{8}{16}$ " between the wheels. This compares with from 28 to 30" on the lighter machine referred to above.

Spindle

There are in use today a large number of floor and bench stands that are equipped with a spindle much too light for the weight of the wheel mounted. It is impossible to reduce vibration to a minimum with a small spindle.

As a matter of economy to the user, all spindles in Norton stands are made larger on the bearing surfaces than between the flanges. This permits of several regrindings before the spindle becomes too small for use. On the 1 $\frac{3}{4}$ " floor stand $\frac{1}{16}$ " of an inch of stock is allowed for regrinding.

The spindles are so threaded that the pressure on the wheels tends to tighten the nuts.

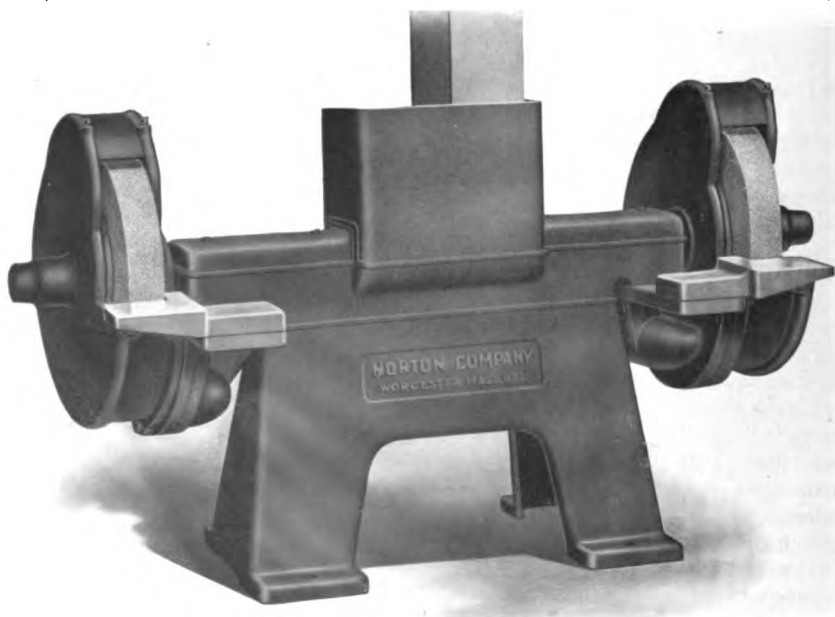
Flanges

The flanges furnished with each Model "D" machine are one-half the diameter of the maximum wheel that can be mounted. Both are relieved to prevent the chance of getting an uneven bearing on the surface of the grinding wheel, one possible cause of wheel breakage. The inner flange is keyed to the spindle making its removal a comparatively simple process.

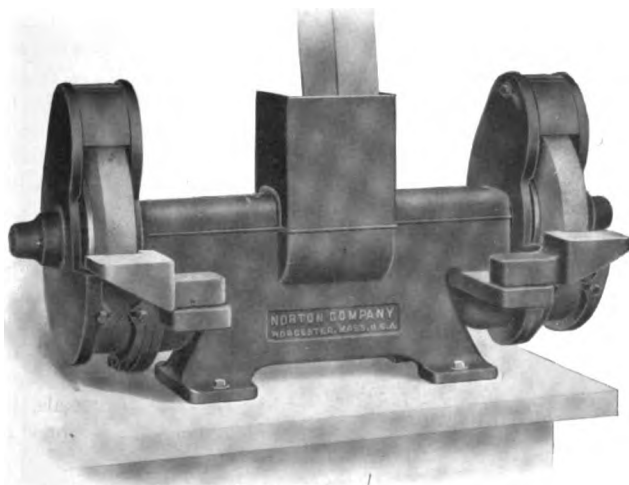
Speeds

A two-step pulley is provided so that the speed may be changed as the wheel wears down, thus keeping the surface speed within proper limits.

The 13 $\frac{1}{4}$ " floor stand when a new 20" wheel is mounted should be running at 1,145 R. P. M. with the belt on the large pulley, giving a surface wheel speed of 6,000 feet. At 16 $\frac{1}{2}$ " the wheel will be running at 4,950 surface feet. By shifting



Norton Floor Stand—Model D



Norton Bench Stand—Model D

the belt to the small pulley on the machine and the large pulley on the countershaft used with this machine, the R. P. M. increases to 1,275. The wheel can then be worn to 15" at which size it will be running 5,000 surface feet. At this size the wheels should be changed to other machines running at a higher speed so that the surface speed can be increased to 6,000 feet again.

Belts

Adequate room is allowed for the use of large belts, so that a sufficient amount of power can be applied to the wheels.

Work Rests

The upper work rest surface is unusually large and very hard, being of chilled iron. Adjustment and removal of the rests can be accomplished quickly by loosening two bolts by which the rests are attached to the machined seat extending from the underside of the bearing bed.

Attachments

Protection hoods, surface grinding attachments and cylinder chucks can be easily attached to this line of machines. Many times long pieces can be rough

surfaced very easily on the surfacing attachment. For squaring the ends of castings, rods and other parts, a grinding wheel cylinder mounted in the cylinder chuck is very useful.

Safety

Safety is of course of first importance as it often means a satisfied workman. If he is sure his task is not a hazardous one, his work is bound to benefit.

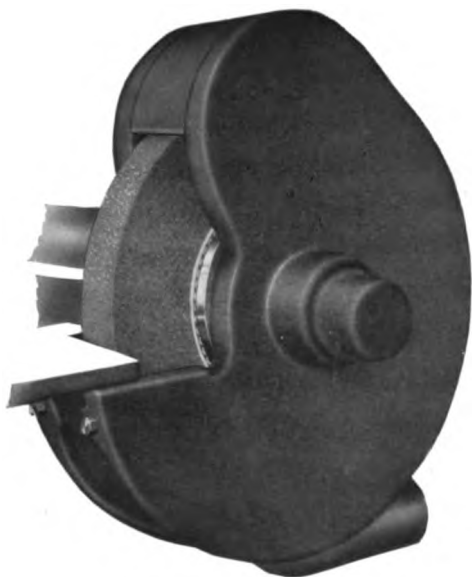
Safety is assured in these machines by:

- Protection Hoods
- Provision for Belt Guards.
- Large Work rests
- Large spindles
- Covered bolts and nuts
- Elimination of unnecessary sharp and protruding parts
- Proper flanges

Protection Hoods

The description of machines for foundry use would not be complete without a word about protection and dust hoods.

Besides protecting the operator from possible wheel breakage, the Norton hoods provide for the efficient removal of



Norton Hood—Closed

the material ground off and dust from the wearing wheel.

They consist essentially of a heavy strip of boiler plate held in place by two heavy side plates. You will notice that about a 60° opening is left as available working space. As the wheel wears, the hood can be adjusted by means of a steel slide so that it is always conveniently located. This is accomplished by arranging the grooves of the slide on an arc rather than a straight line.

The outside plate, it will be noticed, covers the end of the spindle removing the possibility of a workman's clothing becoming caught in the thread or nut. It can be easily removed to permit change of wheels.

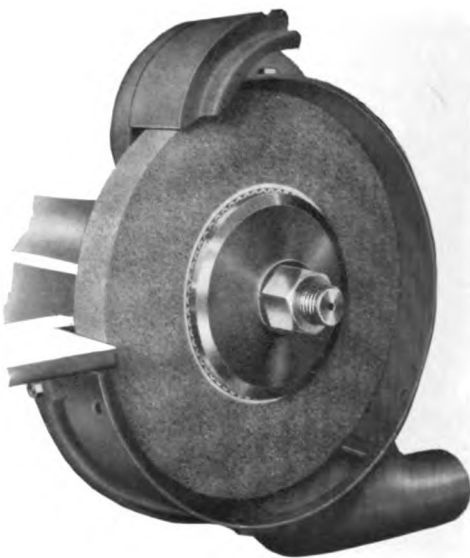
Foundation

The floor stands should be mounted on a very firm foundation, concrete if possible. A good foundation makes possible efficient use of grinding wheels by eliminating vibration and withstanding any pressure that may be exerted on the machine.

Sizes

The Model D floor stands can be furnished in four sizes with 1¼", 1½", 1¾" and 2" spindles. The Model D bench machines, which are designed on the same lines as the floor stands, are made with ¾", 1" and 1¼" spindles. Set on pedestals, they make very desirable small floor stands. An attempt is made to carry these machines in stock available for prompt shipment.

Prices and complete specifications will be furnished on request.



Norton Hood—With Side Removed



Notes From the Files of the Sales Engineering Department

GRINDING FIRE CLAY NOZZLES FOR STEEL POURING LADLES

Fire clay nozzles are used in steel foundries in the bottom of steel pouring ladles. With a graphite stopper they are used for retaining the molten metal. The stopper must of course fit perfectly into the clay nozzle in order to insure a complete cutting off of the steel when a casting has been poured.

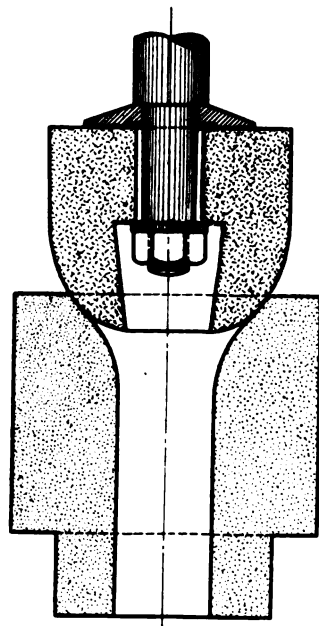
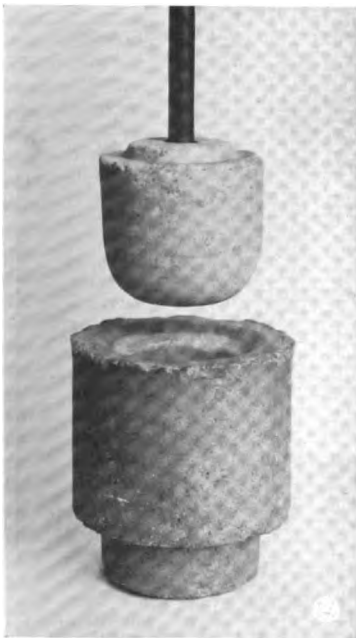
In use the nozzle becomes slagged over, destroying the fit of the plug.

It has been found by a number of concerns that grinding wheels can be very nicely utilized for grinding the seat in new nozzles and also for grinding out the slag in nozzles which have been used.

The wheel is formed to the same shape as the graphite plug and mounted on a vertical spindle so that the wheel can be fed down into the nozzle. The nozzle is held stationary.

Alundum wheels in grain 20 grade 0 have been found very satisfactory; and Crystolon wheels in grain 30 grade N are also successfully used.

The picture shows a wheel ready for use and also the nozzle and graphite stopper. The drawing shows the wheel and nozzle in cross-section, illustrating the countersink necessary for proper mounting and the seat ground.





Nine Hundred Pieces in Ten Hours

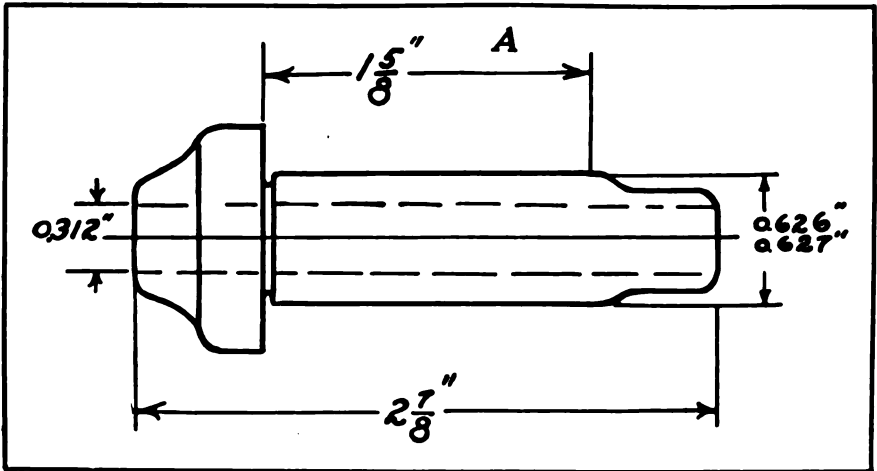


Figure 1

Figure 1 shows a cast iron valve guide that is ground (diameter A) on an arbor. 0.020 stock is removed; limit .001". The machine is a 6" x 32" Norton Grinding Machine. The wheel is a 14" x 2" x 5" 33 N "Crystolon". Output is 900 pieces in 10 hours.

One Thousand Pieces in Nine and One-Half Hours

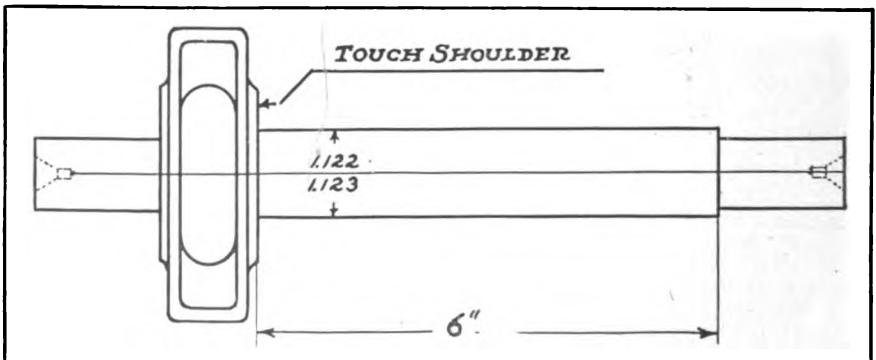
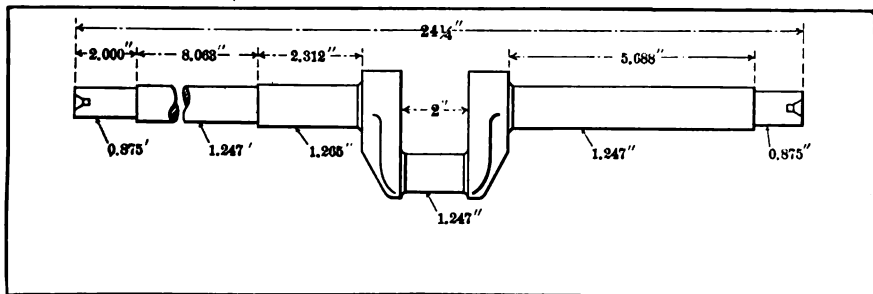


Figure 2

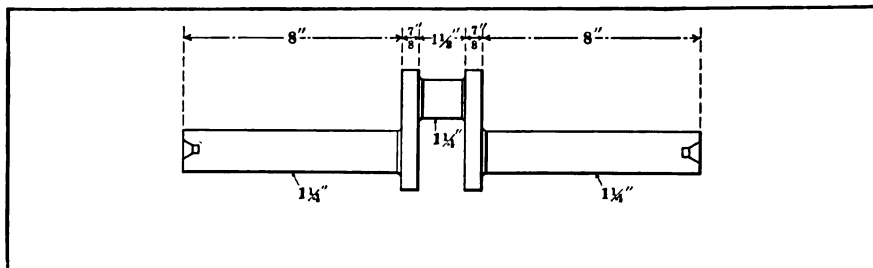
Figure 2 shows a steering gear shaft; .45 carbon steel; 0.035" stock removed; limit 0.001". The machine is a 10" x 24" Special Purpose "Norton" fitted with a 20" x 6 1/2" x 12 1/2" 3824 Comb. Alundum L wheel. The production on this job is 1,000 pieces in 9 1/2 hours.

Two Examples of Norton Grinding Machines Production



Gas engine crankshaft (40 carbon steel)
 Bearings rough turned .030 stock removed
 Pins ground from forging .250 stock removed
 Limit $\pm .0005''$

PRODUCTION—Pins and bearings 60 shafts in 10 hours
 10" x 36" Norton Machine
 20 x 2 x 5 = 24 C.N wheel for pins
 20 x 4 x 5 = 24 C.M wheel for bearings



Gas engine crankshaft (40 carbon steel)
 Bearings rough turned .030 stock removed
 Pins ground from forging .250 stock removed
 Limit $\pm .0005''$

PRODUCTION—Pins and bearings 80 shafts in 10 hours
 10" x 36" Norton Machine
 20" x 1 1/2 x 5" = 24 C.N wheel for pins
 20" x 4" x 5" = 24 C.M wheel for bearings



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the
Grinding Industry that Have Appeared in
Recent Issues

Precision Cutter Grinder. Automotive Industries, July 31, 1919, page 219. Made by Russell, Oldbrooks & Henderson, Inc. This grinder makes possible the use of profile ground form cutters, which are claimed to be superior to the form relieved type, as regards quality and quantity of work produced. A truing device and a cutter jig are furnished.

Disk Grinder with Lever Feed. Iron Age, August 7, 1919, page 364. Single spindle disk grinder manufactured by the Badger Tool Co., Beloit, Wis. The features emphasized are the level feed work table, ball bearing spindle mounting, and the rockershaft construction.

Latest Practice in Cutter Grinding—III. American Machinist, August 7, 1919, page 251. Angular cutter grinding and the grinding of formed cutters as well as the grinding of taps are discussed in this article.

Haskins Die-Sinker's Grinding Outfit. American Machinist, August 7, 1919, page 288. A flexible-shaft grinding outfit intended for die sinking or other work where it is desired to obtain a good finish in pockets or recesses has been developed by the R. G. Haskins Co., 547 West Washington Boulevard, Chicago, Ill.

St. Louis Grinding Stands. American Machinist, August 7, 1919, page 288. A new line of floor type grinding stands has just been placed on the market by the St. Louis Machine Tool Co., 932 Loughborough Ave., St. Louis, Mo.

Grinding at the C. L. Best Plant. Metal Trades, July, 1919, page 291. Description of the grinding department of the C. L. Best Gas Tractor Co. at San Leandro.

"Lumsden" Tool-Grinding Machine. American Machinist, July 31, 1919, page 238. A detailed description of the "Lumsden" oscillating tool-grinding machine which has been introduced into this country by Alfred Herbert, Ltd., 54 Dey Street, New York, N. Y.

Forbes & Myers Electric Double Disk Grinding Machine. American Machinist, July 31, 1919, page 240. Brief description of a new grinding machine placed on the market by Forbes & Myers, 172 Union Street, Worcester, Mass.

Wardwell Model E Saw Grinding Machine. American Machinist, July 31, 1919, page 242. This machine, supplied either in bench or in floor type, is the product of the Wardwell Manufacturing Co., 110 Hamilton Avenue, Cleveland, Ohio.

Lumsden Plain Cup-Wheel Grinder. Machinery, August, 1919, page 1196. Description of the Lumsden ball bearing plain cup-wheel grinder introduced recently by Alfred Herbert, Ltd., 54 Dey Street, New York, N. Y.

Heald Internal Grinding Machine. Machinery, August, 1919, page 1197. For use in grinding short work of small diameter, the Heald Machine Co., Worcester, Mass., has developed recently a No. 85 internal grinding machine.

Special Valve-Grinding Fixture for Hispano-Suiza Aircraft Engines. American Machinist, August 14, 1919, page 316. Detailed description of a fixture designed by the writer. The device clamps on the top of the cylinder block in place of the camshaft and grinds all the valves at one time.

Latest Practice in Cutter Grinding—IV. American Machinist, August 14, 1919, page 323. This article describes the modern practice in hand and chucking reamer grinding for steel, cast iron, and bronze.

Buying Grindstones and a Word about Hones. Foundry, August 15, 1919, page 571.

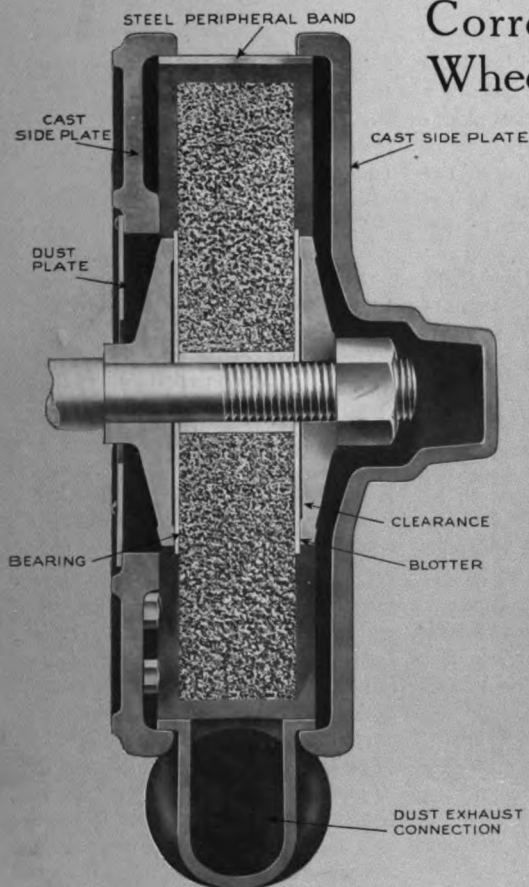
Grinding Band Saw Laps. Wood-Worker, August, 1919, page 39.

Extra Work-Spindle Drive on Landis Grinding Machine. American Machinist, August 21, 1919, page 385.

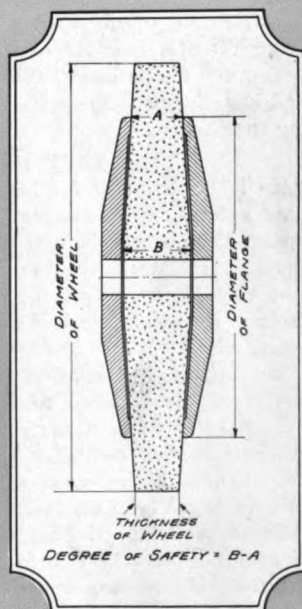
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GRITS and GRINDS

NOVEMBER 1919



Correct Grinding Wheel Mountings



TAPERED FLANGES ARE RECOMMENDED WHERE IT IS NOT PRACTICAL TO USE A HOOD.



Grits and Grinds

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The Causes of Grinding Wheel Breakage

BY HAROLD E. JENKS

The subject of grinding wheel breakage is one which directly concerns every wheel consumer as well as the manufacturer of the product.

Breakage of the wheel affects the consumer, since it means danger to the operator and possibly to others in the shop. It also involves considerable expense, due to the loss of the wheel itself and loss of time in procuring and mounting another one.

It affects the wheel manufacturer, since it is obviously for his interest to have as few breakages as possible charged up against his wheels, and since, if the cause of breakage is clearly due to manufacturing defects, he will be expected to replace the broken wheel at his own expense.

It is important, then, that wheel breakage should be reduced to a minimum. To do this, its underlying causes should be clearly understood, and it is with the purpose of making these causes clear that this article has been written.

Breakage of a grinding wheel while in operation may be due to any one of the following causes, or to a combination of two or more of them:

1. Centrifugal force due to rotation of the wheel.

2. Direct pressure exerted by the work on the wheel.

3. Heating of the wheel or spindle.

4. Grinding on the side of the wheel (side pressure).

5. Improper mounting.

6. Impact on the side or face of the wheel.

7. Cracks or flaws in the wheel structure.

8. Lack of balance.

9. Initial stresses.

It is unavoidable that these causes should overlap to some extent; for instance, heating of the wheel is a result of direct pressure by the work. It is thought, however, that the list has been condensed as much as possible to still retain the desirable property of clearness.

By "stress," as used here, is meant force acting between the particles of wheel material per unit of area—let us say in pounds per square inch. Wheel material is much weaker under tensile stress than under compressive stress—that is, a much smaller force will break it if tending to pull its particles apart than if tending to push them together. For this reason, stresses are herein specified as tensile or compressive, it being understood that compressive stresses are not important



as sources of breakage. Mathematical proof of statements made regarding the amount and position of stresses in wheels is beyond the scope of this article and is therefore omitted.

Much importance should be attached to the fact that although not one of the existing stresses in a wheel may be excessive, the combination or resultant of two or more of them may be sufficient to cause breakage.

1. Centrifugal Force Due to Rotation of the Wheel

In any body which rotates about an axis, stresses are induced at every point due to centrifugal force, which is the force tending to make the body fly apart. In a grinding wheel these stresses are of two kinds: a radial stress acting in the direction of the radius of the wheel; and a tangential stress acting in a direction perpendicular to the radius. Both these stresses are tensile. The tangential stress is much the larger of the two, and *reaches its greatest value at the inside of the wheel—that is, around the circumference of the hole.*

The radial stress has its maximum at a point from one-third to three-fourths the distance from the face of the wheel to the hole. The amounts of both stresses vary as the square of the wheel speed, which means that if the speed is doubled the stresses are quadrupled. For a given peripheral speed and diameter of wheel, the maximum tangential stress increases slightly as the diameter of the hole is made larger, and in cylinder wheels becomes about twenty per cent greater than in disc wheels with ordinary sized holes.

Since a grinding wheel in operation is always revolving, stresses due to centrifugal force always exist; and although it is probable that comparatively few wheels in operation break from these stresses alone, others may easily combine with them and produce breakage.

Reliable grinding wheel manufacturers test all wheels before they leave the

factory by running them at such speeds that the minimum safety factor is $2\frac{1}{2}$ and the maximum in some cases as high as 5. As a result of this precaution, practically all breakages that occur from centrifugal force alone can be traced to such causes as shifting thoughtlessly from large to small pulleys, placing large wheels on spindles running at speeds intended for small ones, or substituting for a wheel running at the correct speed one of different grain and grade and lower recommended wheel speed. In other words, these breakages are nearly all due to carelessness or ignorance on the part of the operator.

2. Direct Pressure Exerted by the Work on the Wheel

By "direct pressure" is meant pressure on the face of a wheel directed toward its center. Stresses produced by this pressure are of two kinds—radial and tangential, or frictional.

The radial stress is the same as would be produced by direct pressure, if the wheel were not revolving, and is compressive. It is usually small in amount and is unimportant as a cause of breakage.

Contact between the particles of the revolving wheel and the work produces a frictional force whose amount is proportional to the direct pressure and which is in the direction of a tangent to the wheel face. This force causes bending stresses along a diametral section of the wheel which are tensile on one side of the center and compressive on the other. These stresses reach their largest value at the face of the wheel, and are usually small and unimportant.

3. Heating of the Wheel or Spindle

Considerable heat is developed at the point of contact of wheel and work, and in cases where grinding is done dry the wheel may become very hot. The stresses produced by unequal expansion of differ-



ent parts of the wheel may in this case reach a large value, and many breakages are probably due to this cause. These stresses are similar to those resulting from centrifugal force, and are (as in that case) of two kinds—radial and tangential. THEY MAY VARY GREATLY IN AMOUNT ACCORDING TO VARIATIONS IN TEMPERATURE OF THE WHEEL, AND AN EXACT DETERMINATION OF THEIR AMOUNT IS DIFFICULT, IF NOT IMPOSSIBLE. The greatest tensile stress occurs around the circumference of the hole and hence combines with the greatest stress due to centrifugal force.

Heating of the spindle may be produced by tight bearings on the machine; and if the wheel bushing fits the spindle tightly, expansion of the latter will cause tensile stresses of considerable magnitude in the wheel, which, adding to the maximum stress due to centrifugal force, may cause breakage.

4. Grinding on the Side of the Wheel (Side Pressure)

Many breakages are directly caused by side pressure, which occurs to a limited extent when work is being traversed across the face of the wheel, but principally when grinding is done on its side. Also, particularly in snagging operations, large side pressure may be produced by grinding on or “working” the corners of the wheel face. The effect of side pressure is to produce a bending stress whose maximum reaches all points of the wheel as it revolves, and which is tensile on the side of the wheel which sustains the pressure and compressive on the other.

Properly designed flanges used on wheels of sufficient thickness are the best protection against breakage due to side pressure. They not only greatly reduce the maximum stress due to this pressure, but prevent its attaining its maximum at the circumference of the hole, where it would other-

wise combine with the maximum due to centrifugal force.

5. Improper Mounting

This subject is of such importance to all grinding wheel users that it is thought advisable to first give the following brief statement of the essentials of correct mounting:

Care should be taken that the sides of the wheel and the sides of the flanges in contact with the wheel are plane surfaces, in order that an even bearing may be secured.

The hole should be of a diameter approximately .005” larger than the spindle or arbor on which the wheel is to be mounted, and must be at right angles to the sides of the wheel, concentric with the circumference. No portion of the bushing should project beyond the sides of the wheel.

The spindle should be perfectly straight and threaded in a direction such that any tendency for the wheel and nut to turn will tighten the nut.

Flanges are used primarily to transmit power from the shaft to the wheel, and for this reason the inside flange must be keyed to the shaft. Both flanges must have plane faces at right angles to the shaft, and should be properly relieved—that is, they should be countersunk so as to bear on the wheel only on the part of the side of the flange nearest the rim.

Blotters or some other form of compressible washers should be used between flange and wheel to insure an even bearing. Their diameter should be at least as large as that of the flanges.

The nut should be tightened only enough to properly hold the wheel. Further tightening is unnecessary and undesirable.

Stresses in the wheel due to improper mounting are particularly important because *they all combine directly with the maximum due to centrifugal force.*



Forcing a wheel on a spindle for which its hole is too small is extremely likely to result in breakage, as large tensile stresses are induced around the circumference of the hole. If the hole is too small, it should be carefully enlarged by scraping until a perfect fit is obtained.

Side pressure producing large tensile stresses may result from any defect in mounting which tends to produce uneven bearing between flanges and wheel, such as bent or broken flanges; projecting bushings; high spots on bearing surfaces of flanges or wheel; flanges not properly relieved; failure to use proper compressible washers; flanges of different diameters, or excessive tightening of the spindle nut.

6. Impact on the Side or Face of the Wheel

Probably most breakages due to impact are the result of carelessness or ignorance on the part of the operator. It should be borne in mind that stresses in a wheel produced by a suddenly applied force are very much larger than those produced by the same force if applied gradually.

The impact of the particles of the wheel on the work in any form of grinding produces certain stresses in the wheel, but these are carried more by the particles in direct contact with the work than by the wheel as a whole, and are not important as a cause of breakage. Cases have been known, however, where ignorant operators, in order to increase the speed of cutting, have hacked the face of the wheel in such manner as to cause breakage due to this form of impact.

Breakages are sometimes caused by bringing heavy pieces of work into too sudden contact with either the face or side of the wheel. Carelessness in snagging castings suspended from chain hoists, for example, might easily produce breakage of this kind.

In work requiring a table traverse, the headstock or footstock may be run into the

wheel, which will cause wheel breakage unless something else gives way first. This is not true impact, but approaches it on account of the suddenness of application of the force, and results in large stresses due to side pressure.

Catching of the work between the wheel and the rest in free hand operations is very likely to cause wheel breakage. Such an accident may be due to improper adjustment of the rest or to lack of attention or ignorance on the part of the operator, and may have very serious consequences. This is a true case of impact, the speed of application of the force being practically the speed of the periphery of the wheel.

7. Cracks or Flaws in the Wheel Structure

Wheel breakage sometimes occurs because of cracks or flaws which are in the wheel before it is put in operation. Such defects may be entirely under the surface of the wheel and therefore not visible. Flaws are manufacturing defects, while cracks may be due to faulty manufacture or to various other causes such as carelessness in transportation, handling, unpacking, or storage.

Due to the fact that the Norton Company uses such extreme care in testing wheels for flaws and cracks, it is practically impossible for a wheel with such defects to pass inspection and be shipped outside the factory.

The "ring" of a wheel, or sound produced by its vibration when tapped lightly with some solid object, is used as one indication of interior cracks or flaws. A wheel with a clear "ring" is fairly certain to be free from such defects, although it has been shown that a poor "ring" does not necessarily mean a defective wheel. Norton Company, however, in order to be on the safe side, rejects all wheels which do not ring clear.

After the test by "ringing" the wheel, all wheels of over 5" in diameter are given a speed test at about double the recom-



mended operating speed, as stated previously. This is a very severe test and is practically certain to eliminate defective wheels.

Rigid inspection follows this speed test and the wheels are very carefully packed for shipping in strong boxes made especially for the purpose.

Breakages due to cracks are therefore beyond the control of the Norton Company since these cracks must occur subsequent to the time the wheels are shipped.

8. Lack of Balance

A wheel that is out of balance has developed in it stresses of rather complex character. In cases where the lack of balance is very great, breakage may result, either from these stresses or from impact, as will appear below. Lack of balance may be due to several causes whose description follows:

Variations in density in a wheel may cause imperfect balance. However, this can hardly prove serious in the case of wheels furnished by any reliable grinding wheel manufacturer, as the homogeneity of structure of such wheels precludes the possibility of a dangerous amount of lack of balance.

If a wheel goes out of true for any reason, it will also go out of balance, since its center of rotation will no longer be at its center of gravity. Wheels may go out of true from such causes as a bent spindle, loose bearings, loose frame, improper use, or from the hacking of the wheel face previously mentioned. If a wheel is seriously out of true, it will deliver a series of blows to work thrust against it, thus producing large impact stresses. The stresses due to the centrifugal force of the out of balance portions of the wheel may also become large in this case and will combine with the maximum due to centrifugal force.

A wheel should not be allowed to stand partially submerged in water or other

liquid, for when it is started in motion the wet portion is much heavier than any other and hence the wheel is greatly out of balance. Several cases of breakage from this cause are known.

9. Initial Stresses

During the process of manufacture of any solid body, initial stresses are sometimes set up in the material of which the body is composed. Unless great care is used in its manufacture, a grinding wheel may have such stresses existing in it. These may be regarded as incipient flaws or cracks and may combine with other stresses to increase the maximum stress in the wheel. No method has yet been devised for determining the existence of initial stresses in wheels. However, Norton Company by the speed test mentioned above eliminates from its finished product all wheels with large initial stresses. By running all wheels at double the recommended operating speed and thus quadrupling the stress due to centrifugal force, any wheels having extraordinary initial stresses are broken.

On account of the number and variety of the possible causes of wheel breakage given above, it is easily seen that the actual determination of the real cause of breakage of a single wheel may be difficult or impossible. In cases, however, where breakages occur consistently with a certain operator or on a certain machine or operation, it may be reasonably assumed that there are one or two principal causes involved which can by a study of the situation be detected and removed.

A conservative statement, based on experiments, investigation, and long experience with wheel breakages, is that practically all breakages are due to causes beyond the control of the grinding wheel manufacturer and may in no way be attributed to weakness in wheel structure.



Notes From the Files of the Sales Engineering Department

ALUMINUM GRINDING

The increase in the amount of aluminum and aluminum alloys used in the manufacture of automobiles, cooking utensils, shoe lasts, and vacuum cleaners quite naturally increases the importance of aluminum grinding and polishing. Because of its softness, aluminum is easily scratched and tends to load the wheel quickly during grinding. However, if proper consideration is given the choice of wheels and other important factors, this metal can be ground quickly and, in the case of precision grinding, to a very fine finish.

Snagging

For snagging the rough castings there is not one particular wheel which can be considered standard. Most of the snagging wheels, probably at least 80%, are made by the elastic process. The chief difficulty to overcome is loading of the wheel face. Because the face of elastic wheels breaks down easily under the influence of heat, this type of bond is ideally adapted to use in aluminum snagging wheels.

In elastic wheels both Alundum and Crystolon abrasives are used, the former being a little less common. With both abrasives, the grain and grade are about the same and vary from grain 30 grade 6 to grain 46 grade 4. The variation is due to the difference in the finish requirements and in the severity of the grinding.

When vitrified wheels are used, a grain 30 or 36 grade P or Q Crystolon wheel will be found satisfactory.

Cylindrical Grinding

The principal operation under this type of grinding is, of course, finishing aluminum or Lynite pistons. The common method used is to feed a 2" wide wheel straight in at one end and remove all except .001" at one traverse. Using the automatic traverse, the remaining material can be ground off in steps of .00025" or .0005". Excellent results are obtained with a grain 36 or 40 grade J Crystolon wheel. In a few cases a 24 combination grade J or K Alundum

vitrified or 3836 grade 2 Alundum elastic wheel is used.

Possibly of equal importance with the choice of wheel is the use of a suitable lubricant. Kerosene, a mixture of kerosene and lard oil, and Aqualene give best results. To prevent scratching, the grinding solution should be changed often. A fine wire or cheese-cloth screen tied over the tank end of the water pipe is very serviceable.

About the only other cylindrical grinding encountered is the finishing of bushings. This is usually done on a universal machine or a lathe equipped with a tool-post grinder. Small elastic wheels 6 or 8 x $\frac{1}{2}$ " grain 60 grade 2 or 3 will give good results.

Internal Grinding

This work is confined almost entirely to grinding bushings. Where possible, a lubricant should be used. The three mentioned above should be found entirely satisfactory and in our laboratories we found an emulsion of 10% lard oil and 90% water gave excellent results. A grain 24 grade J Crystolon vitrified wheel seems best adapted.

Surface Grinding

On a machine of the Brown & Sharpe No. 2 surface grinder type, the same wheels are used as for internal grinding.

Using a thin-rimmed cylinder on a vertical-spindle machine such as the Blanchard and Pratt & Whitney, No. 38 Alundum silicate wheels are used. There are, of course, several factors influencing the wheel action, but a grain 3824 grade I Alundum silicate wheel is a good all-around wheel.

Polishing

Cotton buff wheels set up with 70, 80, or 90 Alundum for roughing and 120, 150, or 180 Alundum on felt or bull neck wheels for finishing give best results. It is good practice to use either oil, tallow or tripoli from start to finish.



Grinding Helps for the Cleaning Room Foreman

By R. M. JOHNSON

By snagging is generally meant the rapid removal of large quantities of metal from castings as they come from the moulds. Usually no attention is paid to the finish obtained. The operation is merely being useful in removing fins, sprues and irregularities quickly and easily. The castings vary in size from a few ounces to several thousand pounds. Good moulding practice keeps the amount of material to be removed to a minimum. The larger castings have large areas to be ground and considerable quantities of metal to be removed, whereas very small castings may have only a little grinding to be done where the sprue is broken off.

Choice of Wheels

As for any machining operation, most efficient results are obtained only by choosing the most efficient tools. Probably there is no other machining operation with as great an opportunity for varying the tools as in grinding. Because of this, grinding should be and, if carefully supervised, is a very efficient process. Consider the possible number of different wheels that can be made in grains varying from No. 8 to No. 200 and even finer and in grades G to Z, of several different kinds of abrasive.

Choice of wheels is dependent among other things on the following factors:

- Kind of material to be ground
- Size and shape of castings
- Finish desired
- Amount of stock to be removed
- Kind and condition of machines
- Wheel speeds
- Personal factor

This may indicate why it is impossible to recommend off-hand the most satisfactory wheel for any given snagging operation. From a general description

of the most important conditions we are able to make a general recommendation which will be fairly close to the most efficient wheel. Tests under actual operating conditions are the only absolute way of determining the best wheel. Some general remarks may be interesting and helpful.

High tensile strength materials are most efficiently ground with Alundum wheels; those of low tensile strength should be ground with Crystolon. Therefore, for steel and annealed malleable iron use Alundum; and for gray iron, brass, bronze and unannealed malleable, Crystolon should be used. Practically the only exceptions to this general rule are in those cases where castings are made of phosphor or manganese bronze and of aluminum.

Rough castings with thin sharp fins and covered with considerable semi-vitrified sand take harder wheels than smooth castings with large plane surfaces.

The better the finish required, the finer the wheel must be and in order that the cutting action may not be too greatly decreased, the wheel must be of a softer grade.

Large amounts of stock can be removed faster, generally, with coarse wheels than with fine ones. There is an exception to this rule. When we have reached the limit of depth to which a grain can penetrate, it will reduce production rather than increase it, if a coarser wheel is used. A wheel should be coarse enough to allow maximum penetration and clearance, but no coarser. Often finer, softer wheels remove more material per wheel and faster than coarse hard wheels. The harder the material is, the finer the wheel can be to get maximum cutting ability.



Floor and bench stands of rigid construction set on firm foundations take softer wheels than portable machines of the swing frame or flexible shaft type, because there is less vibration in the former group. Poor bearings make harder grades necessary for the same reason. Out of balance rotating parts have the same effect.

The effect of wheel speeds and personal factor will be discussed a little further on in this article.

The range of wheels generally used in snagging high tensile strength materials is from grain No. 10 to grain No. 30 and from grade P to W Alundum; whereas for low tensile strength materials grain No. 14 to No. 30 and grade P to U Cryston are the extremes.

Machines

Small castings up to about 100 pounds are ground on floor and bench stands usually mounting two wheels. In an article in the October issue the Norton Model D stands are discussed in detail. They are admirably adapted for this type of grinding.

Castings which cannot be handled by two men or by the help of a small chain hoist are ground with swing frame grinders. These consist merely of a rigid center shaft with a yoke at one end for mounting the wheel, its weight and that of the flanges being counterbalanced by the motor or suitable weights. Near the center of the machine, the whole is attached to an overhead support so that the wheel may be moved in practically any direction. The work is placed either on the floor or a low platform and is held stationary merely by its own weight.

For grinding in grooves and corners of large castings, a small portable machine is useful. They are of three types — electric, pneumatic and flexible shaft. For the best results we believe an electric machine with the wheel mounted on the motor spindle is most satisfactory. It is

compact, has a positive drive and is complete in itself with the exception of the two wires which may be attached to a wall or floor terminal. Its greatest advantage is its ability to retain the proper speed during grinding. The pneumatic is easily slowed down under grinding pressure and is somewhat inconvenient because of the compressed air hose which must be attached.

Size of Wheels

There is no standard size wheel that is the best for snagging. In general, it is advisable to use as large a wheel as possible on a machine, for the larger the wheel the fewer the stubs to be thrown away. Comparing an 18 x 2 x 2" wheel, $\frac{3}{4}$ " taper both sides with a 24 x 2 x 2" $\frac{3}{4}$ " taper, each available cubic inch of wheel costs about 10% less using the 24" wheel. This is based on the assumption that the wheels are worn to 8" and also that each cubic inch of wheel will grind off the same amount of stock.

As a matter of fact there are three reasons why the material per cubic inch of wheel wear constantly decreases as the wheel wears. They are:

1. Decreased wheel speed
2. Reduced arc of contact
3. Reduction of the momentum

As the wheel wears, the surface speed decreases unless the r. p. m. is increased constantly and very frequently so that surface speed will vary only a very little from the standard. This will be taken up a little more in detail later.

The smaller the diameter of a grinding wheel the smaller the arc of contact, and the fewer the number of particles that are cutting at any particular instant. As a result the pressure on each particle is so much greater and the amount of work each must do to keep production constant is increased to such an extent, that the strain on the bond causes faster crushing with resultant increased wear.



The rotation of a larger wheel results in a much greater momentum than with small wheels. When high pressure is applied, this momentum is helpful in pushing the particles through the metal. It is comparatively easy to reduce the speed of a small diameter wheel by pressure. This results in a greater wheel wear and also a slowing up of production.

The most common wheel diameters used for snagging large castings on floor and swing frame machines are:

Swing frames	18 and 20"
Floor stands	20 and 24"

Wheel Speeds

We most strongly recommend that snagging wheels be run at a speed that will keep the surface speed between 5000 and 6000 feet per minute. The nearer a wheel can be held to a given surface speed the more nearly constant will be the action of a grinding wheel. Also the lower the speed, the more wheel wear results from the removal of a unit of stock.

The reason for this is that in order to keep production constant each particle must remove more material at each cut and at a much slower speed. This means increased pressure on the particle which results in fracture or pulling out of the grain more quickly than at the proper operating speed. Let us consider this from another angle. To remove a certain amount of material, a certain amount of energy must be expended. This energy is stored in the abrasive grains and the amount in each grain is dependent on the speed. Since this energy varies as the square of the surface speed, a reduction in wheel speed results in a much larger reduction of energy available for removing material in a number of grains. Therefore the resistance of the metal cannot be counteracted by the grains as efficiently

as at the higher speed and the grains are more quickly shattered and pulled from the wheel face.

Such a condition can be bettered and practically eliminated by using a variable speed motor or by using cone pulleys so that the speed may be increased as the wheel wears. Keep the speed within the limits of 5000 and 6000 surface feet per minute. If only one speed is possible, change the wheels to machines that are speeded higher than the ones they are first mounted on. As the stubs are taken from the several groups of machines they can be stocked the same as new wheels, except of course when they have been worn to the smallest diameter which it is possible to use.

Personal Factor

Personal factor has a directly important bearing on the action of a wheel as well as life and production. For instance, consider a swing frame grinder. The machine may be tipped so that grinding is done on the corner of the wheel which is conducive to higher wheel wear than when grinding with the flat face.

Moreover, there may be a large number of weights hung on the machine arm. In such a case the pressure of the wheel on the work is increased with the result of high wheel wear.

An operator may "bang" the wheel on the casting or carelessly run into projections or heavy fins. Corners are knocked off the wheels with no resultant increase in production, but with considerably increased wheel wear.

Careless dressing is often a cause of excessive wheel wear.

In studying snagging problems, all of these points are of sufficient importance to demand considerable attention.

General Recommendation for Snagging Castings

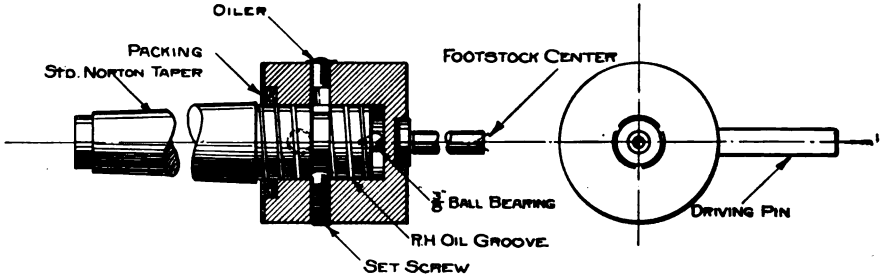
Material	Machines	Grains	Grades	Abrasives
Open hearth steel	Swing frames	10 to 12	S to W	Alundum
	Floor stands	12 to 16	Q to S	"
	Small bench stands	24 to 36	O to Q	"
	Portable	16 to 24	Q to S	"
High speed and High carbon billets	Swing frames	12 to 20	Q to S	"
	Portable	16 to 20	Q	"
Manganese steel	Swing frames	6614	Q to U	66 "
	Floor stands	6614 to 6616	Q to T	66 "
Gray Iron	Swing frames	16 to 24	R to U	Crystolon
	Floor stands	16 to 24	R to U	"
	Small bench stands	24 to 36	P to R	"
	Portable	24	S to U	"
Aluminum	Floor stands	30 to 46	4 to 6	Crys. & Alun. Elastic Crystolon
		24 to 30	P to Q	
Brass and Bronze	Floor stands	24 to 30	P to R	"
	Small bench stands	30 to 46	M to P	"
Unannealed Malleable iron	Floor stands	16 to 24	R to U	"
	Small bench stands	24 to 36	O to R	"
Chilled iron	Same as unannealed malleable iron			
Annealed Malleable iron	Floor stands	10 to 14	Q to U	Alundum
	Small bench stands	24 to 36	O to Q	"

All wheels made by the vitrified process unless otherwise specified.

It should be understood clearly that these recommendations are merely intended as a guide and to show the general range of wheels used.

Even in foundry work, the speed of the grinding wheel is important. It must be held within certain limits, if proper cutting action and economy in wheel consumption are to be obtained.

Fixture for Grinding Valve Tappets



The above illustration of a fixture for grinding valve tappets consists of a special headstock center which is turned down on the end, and a sleeve in which is fitted a driving pin. This sleeve has a close running fit on the headstock center, takes its thrust on a $\frac{3}{8}$ " ball and is held from working off by a loose-fitting

set screw running in the slot as is shown in the illustration. The head of the valve tappet fits in the end of this sleeve which is recessed on a taper and undercut to give a three point bearing, as well as to provide driving means for the work.

We are indebted to J. A. Brenner of Hanover, Pa., for the design of this fixture, which Mr. Brenner has used extensively in the grinding of valve stems, increasing production considerably over the usual standard practice in performing this operation.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

New Plain Grinder. American Machinist, European edition, August 16, 1919, page 135E. Description of a new machine made by Morton & Weaver, Coventry.

Manufacture of Abrasive Wheels. Journal of the American Ceramic Society, August, 1919, page 638. A general discussion of the processes and materials employed in the manufacture of grinding wheels.

Art of Properly Grinding the Twist Drill. Canadian Machinery, September 4, 1919, page 249. A series of notes and sketches showing how to grind correctly twist drills in the Norton grinding machines.

First-class Flexible Grinder Improvisation. Canadian Machinery, September 4, 1919, page 259.

GRITS and GRINDS

DEC 16 1919

December

1919

"My thanks are due to the millions of my fellow citizens of Massachusetts," said Governor Coolidge recently, when asked to make a statement on the result of the election. "I offer them freely, without undertaking to specify, to all who have supported the great cause of the supremacy of the law. The heart of the people has proven again sound and true. No misrepresentation has blinded them, no sophistry has turned them. They have listened to the truth and followed it. They have again disappointed those who distrusted them. They have turned away from those who sought to play upon their selfishness. They have justified those who trusted them. They have justified America.

"The attempt to appeal to class prejudice has failed. The men of Massachusetts are not labor men, or policemen, or union men, or poor men, or rich men or any other class men first; they are Americans first. The wage earners have vindicated themselves. They have shown by their votes that they resent trying to use them for private interests, or to employ them to resist the operation of the government. They are for the government. They are against those who are against the government. American institutions are safe in their hands. Some of those who have posed as their leaders and argued that the wage earners were patriotic because those leaders told them to be may well now inquire whether the case did not stand the other way about. It begins to look as if those who attempt to lead the wage earners must first show that they themselves are patriotic if they are to have any following. The patriotism of some alleged leaders was not the cause but the effect of the patriotism of the wage earners.

"Three words tell the result. Massachusetts is American. The election will be a welcome demonstration to the nation and to people everywhere who believe that liberty can only be secured by obedience to law."

GOVERNOR CALVIN COOLIDGE



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Plow Grinding

By G. A. PARK

Within the last 15 or 20 years the progress made in the manufacture and design of agricultural implements has been extremely rapid. This progress has not been confined to any one type of implement, but has been directed rather toward all kinds. The results have been reflected directly in the agricultural activity of the country, which is admittedly one of the most fundamental branches of industry.

The modern farmer no longer labors under the disadvantage of his forefathers who were forced to use crude or makeshift implements in their work. By means of the present-day agricultural implements, farming may be carried on in a systematic manner with a very noticeable and gratifying diminution of the physical and mental force required in years gone by. In most of the farming tools of to-day such strides have been made that comparatively little attention is required in their manipulation.

The plow, perhaps, furnishes as good an example of the progress made as any other agricultural tool. Its position in the farming industry is indisputable—it is something that is absolutely necessary. The need for various types of plows in different sections of the country, due to the peculiar nature of the soil in which they are to be used, or in order to suit the individual requirements of farmers, has been met by the manufacturers very satisfactorily.

From the very lightest style to the heaviest duty gang plow, the range afforded for selection is quite complete. The different types built to meet these various requirements may be composed of chilled iron, hardened steel, or a combination of either or both with soft steel.

Naturally the business of manufacturing these implements has flourished. Instead of being made by the village smiths, they are now manufactured in up-to-date factories under modern efficiency methods.

Prominent in the industry of present plow manufacture is the modern grinding wheel. Its importance can better be appreciated when it is known that practically all of the major parts are ground at some time during their manufacture. It is to be expected then that with this vast need for grinding, careful and thorough tests would be conducted to establish the maximum efficiency as related to the grain and grade of wheel used and the machine equipment. In most cases heavy rigid floor stands are used—sometimes of special design—for mounting the grinding wheels. Other special types of machines as, for instance, the jointing machine, using a cylinder wheel, are also extensively employed. The machines and wheels used represent, therefore, the results of careful investigations carried on by the various plow manufacturers. A few of the most important parts on which grinding is done are shown on the following page:



MOULDBOARDS

Grinding is done on the edges and on the surfaces of the mouldboards. The various parts which go to make up a plow base must also be fitted to one another by grinding. Mouldboards are generally composed of chilled iron or hardened steel, although they are sometimes furnished in soft steel also.

Wheels 20 to 24" diameter and $2\frac{1}{2}$ to

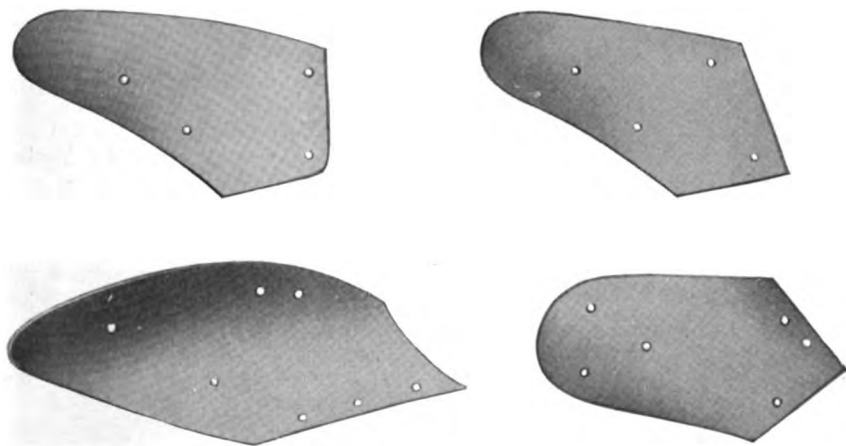
16 x 3" to 30 x $3\frac{1}{2}$ ", bevelled both sides.

For Hardened and Soft Steel Some Chilled Iron

16-R and S Alundum vitrified
20-R and S Alundum vitrified
24-Q Alundum vitrified

For Chilled Iron Entirely

16-T or U Crystolon vitrified
20-S to U Crystolon vitrified



Mould Boards

$3\frac{1}{2}$ " thick, with tapered sides, are used mostly. The methods of grinding vary with the different shops. In some plants a cradle is used for holding the work against the wheel. This cradle is located underneath the wheel and is pivoted on one end. There are two handles on the front of the cradle with which the operator manipulates the whole device.

In other shops the operation is offhand, and in one or two cases swing-frame machines have been used.

In general the grinding on mouldboards is most successfully done with wheels from

LANDSIDES

These are ground on the edges and sides. They are fitted to the other plow parts by grinding also. Usually the operation is offhand using wheels from 14" diameter up and 2" or more in thickness.

The wheels used vary from 14 x $\frac{3}{4}$ " to 24 x 2" and cover the following grains and grades:

For Hardened and Soft Steel Some Chilled Iron

20-P to S Alundum vitrified
24-O to R Alundum vitrified



Land Sides

SHARES AND POINTS

Shares and points are ground after the plow base has been assembled as integral parts of the whole, and they are also ground separately as repair parts or when fitting and shaping the pieces during, or prior to, the assembling process. They are composed of chilled iron, hardened steel, or soft steel. The grinding is done on wheels from 18 to 30" in diameter by $2\frac{1}{2}$ to $3\frac{1}{2}$ " thick. Occasionally smaller wheels are used depending upon the equipment or methods in the various plants. In the fitting operation the grinding is usually done offhand, but for surfacing the work, the cradle described under "Mouldboards" is used.

a 2" rim. The following grains and grades have been found successful:

Hardened and Soft Steel Some Chilled Iron

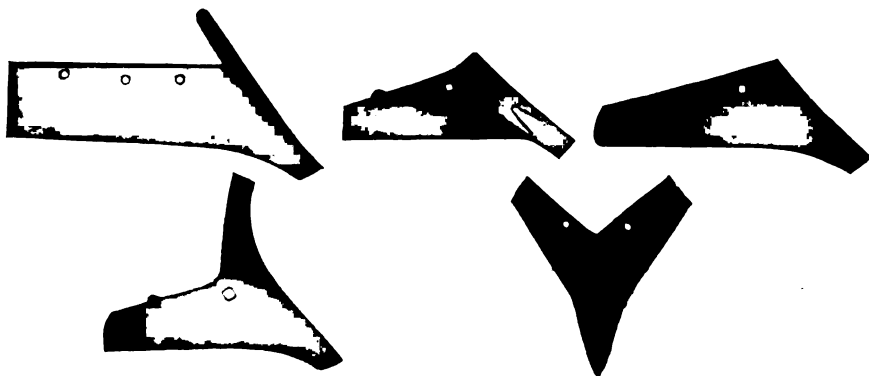
16-Q to S Alundum vitrified
20-N to P Alundum vitrified

Chilled Iron Entirely

16-Q Crystolon vitrified

Assembled Plow Bases

When the various parts of the plow bases have been assembled, they are ground again to finish up rough edges, remove protruding rivet or bolt heads and to touch them up generally. The full length of the joint between the mouldboard and the



Shares and Points

The edging or jointing of the plow shares is accomplished by using a cylinder wheel on a special jointing machine. The work may be clamped to the bed of the machine and traversed past the wheel by hand. The cylinder wheels most generally used are about 16" diameter by 8" thick with

share is ground for a width of 4 to 6" to even the joint and produce the proper curvature at this point. This operation is done ordinarily on wheels 24 to 30" diameter by $2\frac{1}{2}$ to $3\frac{1}{2}$ " wide, using the cradle for applying the work to the wheel while being ground.



In general the grinding operations might be listed as follows for grinding assembled plow bases and such work:

GENERAL GRINDING PLOW BOT-TOMS, BASES, SHARES, MOULD-BOARDS, AND SHOVELS

Wheels 16 x 3" to 30 x 3", bevelled both sides.

Hardened and Soft Steel Some Chilled Iron

- 16-R and S Alundum vitrified
- 20-R and S Alundum vitrified
- 24-Q Alundum vitrified

Chilled Iron Entirely

- 16-T or U Crystolon vitrified
- 20-S to U Crystolon vitrified

GENERAL FITTING OF PLOW PARTS

Wheels 14 x $\frac{3}{4}$ " to 24 x 2".

Hardened and Soft Steel Some Chilled Iron

- 20-P to S Alundum vitrified
- 24-O to R Alundum vitrified
- 12 Alundum rubber

Chilled Iron Entirely

- 20-S to U Crystolon vitrified

Grinding in the plow industry is done both wet and dry. Usually where hardened steel or chilled iron is being ground the operation is wet (using water); on the other hand, in those cases when soft steel or cast iron is ground, the operation is dry. This is largely because of the danger of burning the harder metal when grinding dry.

POLISHING

The final finish is produced on the various plow parts with abrasive grain glued on polishing wheels. The kind of polishing wheels used may vary from shop to shop, depending upon local conditions. For example, compressed polishing wheels are used in some plants, and stitched

cotton buff wheels have been found more successful in others.

A cradle is used to apply the work to the wheel in some cases, and in others the polishing is offhand. This depends somewhat upon the shapes and sizes of the parts polished and upon the equipment in the various shops. A cradle arrangement with attachments to hold the parts being polished usually enables the operator to turn out more work because of the greater pressure obtained.

For the first polishing operation on plow bases, mouldboards, shares, shovels, and such, Nos. 24, 30 and 36 T. J. Alundum have proven particularly well adapted. The advantage with Alundum is that a comparatively large percentage may be reclaimed for further use. This point is quite important in view of the initial cost of abrasives.

For the final polishing operation T. J. Alundum, grits Nos. 80 to 120, are used. The most satisfactory grit in each shop can best be determined by a thorough test of several different sizes.

One of the most important factors in polishing work is the use of a good glue, properly prepared. Our booklet on polishing contains a number of practical suggestions and will be sent upon application to those interested.

This article is intended as a general outline of the plow industry as related to Alundum grinding wheels and Alundum grain. The facts given are based upon actual tests and records. However, it is likely that in a few special cases the data given would not apply because of somewhat different conditions than are found in the ordinary shops. In these cases coöperation to the utmost with the shops in question will be given in order to determine the most suitable wheels and abrasive grain for their work. Engineering suggestions, the benefit of a broad experience, and complete records are entirely at the disposal of those interested.

Alundum Grain for Polishing Inner Tube Mandrels Before Sherardizing

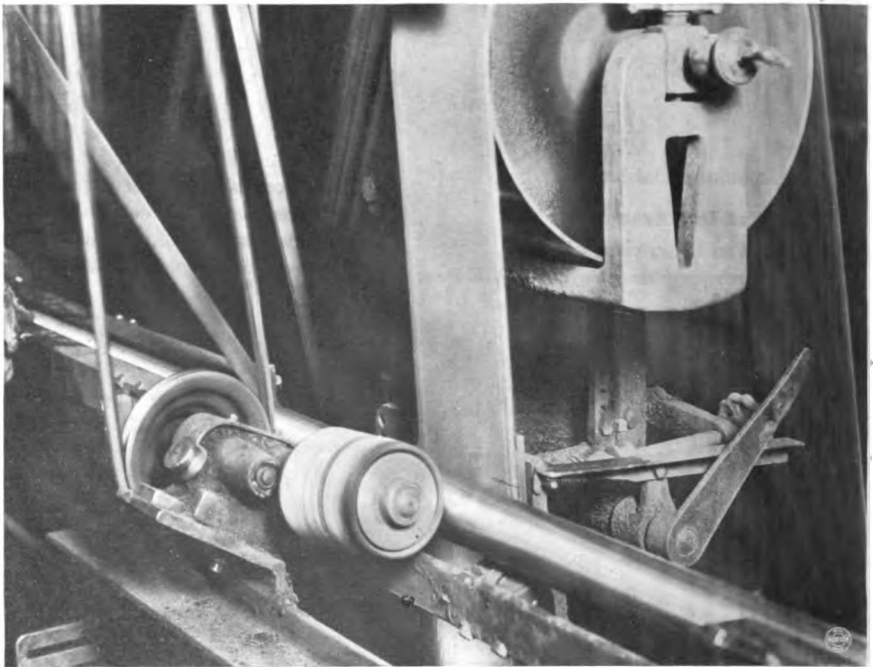
By C. L. SHAW

It is only within a few years that the application of zinc to other metals to produce a rust-proof surface by a process now known as "sherardizing" has become a vitally important factor in the production of rubber inner tubes for pneumatic tires. The New Haven Sherardizing Company, of New Haven, Conn., in whose plant the following information was obtained, was the first concern to use this process in the treatment of tube mandrels, producing the first lot only five years ago.

The results obtained were so satisfactory that further experiments were carried on and to-day the sherardized mandrel is

used by practically every manufacturer of inner tubes in the country.

The process of sherardizing is not merely the applying of a coating of zinc to another metal, as in galvanizing, but is a process whereby zinc in the form of fine dust penetrates into the pores of the metal for a distance of five to eight thousandths of an inch, and forms an alloy with the base. The zinc dust used in this work is of special manufacture and contains about 85 per cent pure zinc. It is obtained from the hoods of zinc smelters where it is formed by the condensation of zinc vapors, and is bolted through a very fine mesh screen.



Polishing by Means of a Belt Coated with Alundum Grain. This Operation Takes Place before the Process of "Sherardizing"



Sherardizing is not confined to the treatment of tube mandrels which are discussed in this article, but has already proved a success on nails, bolts, screws, trolley fixtures, chains and other such articles.

These tubes as they are received at the sherardizing plant are the very highest grade of cold-drawn seamless Shelby steel tubing, in 10-foot lengths and ranging from $\frac{1}{4}$ of an inch to 12 inches outside diameter.

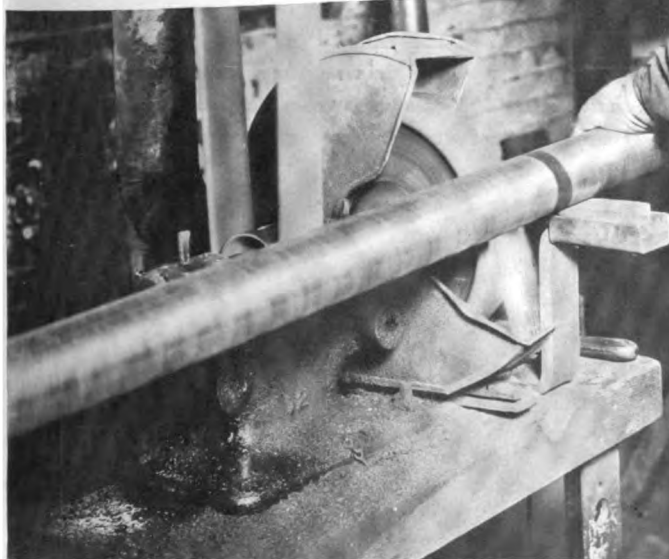
They must be cleaned and polished before going to the treating ovens, and Alundum grain is used for this work in each of the six polishing operations.

The rough mandrel is first cleaned on a Blevney automatic polishing machine using a 14-foot endless belt, 6 inches wide, and coated with number 36 T. J. Alundum grain. The belt runs at 5,400 surface feet per minute, the work at 160 to 200 r. p. m. and a 10-foot mandrel passes through the machine in one minute.

From this machine the mandrel goes to a

polishing wheel, size 12 x 3, which is set up with a combination of 36 and 46 T. J. Alundum grain and makes a speed of 3,200 r. p. m. or 10,000 s. f. p. m. Here the work is fed along the face of the wheel by hand and is slowly rotated at the same time, making a long spiral cut the entire length of the mandrel. Whenever a hollow or dent appears, the operator stops the forward feed and works the hollow spot on the wheel for a moment in order to remove any foreign matter or rust that was not taken off by the first operation.

They go next to the polishing machine and are given four passes on Blevney au-



The Mandrel is Fed Along the Wheel by Hand—the Second Operation

tomatic machines, each pass using a finer abrasive—36, 46, 70, and 100 T. J. Alundum grain respectively. The first pass is made with a work speed of 160 to 200 r. p. m. and the last three with a work speed of 350 to 400 r. p. m., in all cases the belt running at 5,400 s. f. p. m.

The mandrels are now ready for treatment and are sent directly to the sherardizing ovens where the zinc dust alloys itself

with the steel and gives a zinc alloyed coating. From the treating ovens the mandrels go back into the shop and are given a very high polish.

All the way through, Alundum grain is used in preparing the material for sherardizing and the excellent results obtained furnish another instance where it has proved satisfactory for both free hand and automatic polishing.

Trolley Ear Grinding

By W. F. BRETSCHNEIDER

The United Railways Company of St. Louis, Mo., have adopted Norton grinding wheels for finishing the slots and sides of brass trolley ears. This is commonly made a milling operation. These ears are cast in the foundry of the United Railways Company and are brought to the grinding room in a rough condition covered with sand.

For grinding the slots, which is the first operation, they have developed the machine shown in figure 2. It consists of a table, through the slot of which projects

the cutting edge of the wheel. The table is provided with an adjustment for raising or lowering it, to compensate for the wheel wear. Adequate precautions have been taken for the safety of the operator by enclosing the section of the wheel below the table with a protection device. This protection hood is connected to a dust system whereby the greater part of the chips are removed. Further protection is provided by a heavy glass plate above the wheel, which prevents particles from reaching the operator's eyes. The operation of slotting



Figure 1
Trolley Ears with Bolts Attached Making Them Ready for the Trolley Wire

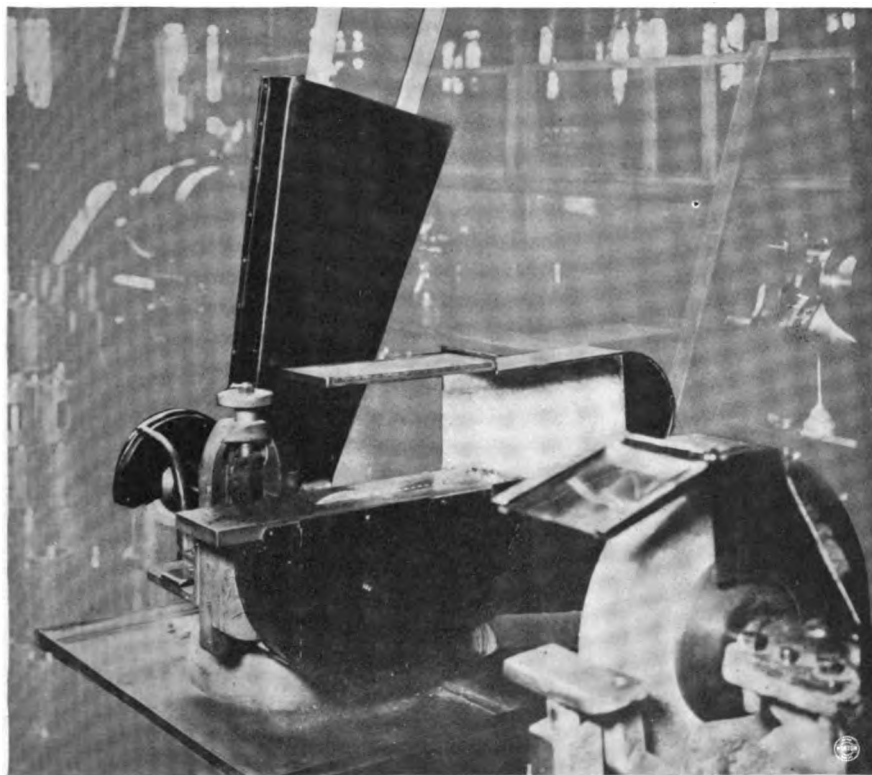


Figure 2

Machine Developed by United Railways Company, St. Louis, for the Grinding of Slots, the First Operation in Trolley Ear Grinding

the ear consists merely of sliding the piece along the table allowing the wheel to clean the sand and surplus metal from the slot.

The machine for grinding the sides of the ears, shown in figure 3, is provided with a long work rest, which is adjustable to compensate for the wear of the wheel. A rib running the length of the rest fits into the slot of the ear, and allows the ear to be slid along the rest and at the same time to be forced against the wheel.

On the slotting operation a Crystolon

wheel $8 \times \frac{3}{8} \times \frac{3}{4}$ ", grain 46 grade P, is used. This finishes from 1,200 to 3,100 castings, depending of course upon the condition of the castings when they come from the foundry.

On the siding operation a Crystolon wheel $12 \times 1\frac{1}{2} \times 1\frac{1}{4}$ " or $12 \times 2 \times 1\frac{1}{4}$ ", grain 24 grade Q, is used. The total production of this wheel varies also according to the condition of the castings, but averages approximately 19,000 ears.



attached making them ready for the trolley wire. The grinding operations are performed previous to the attaching of the bolts.

All grinding wheels, whether used for precision or off-hand operations, should be kept in truth. Many times a wheel is accused of having hard or soft spots when the difficulty comes from lack of truth.



Notes from the Files of the Sales Engineering Department

STOVE GRINDING

Stove grinding is divided into five major operations: snagging the rough castings, mounting and fitting, notching, grinding out the cover holes and surfacing the tops. After grinding, the stoves are polished with loose abrasive grain glued to polishing wheels. Most stoves are made either of cast iron or malleable iron, although there is a little wrought iron used.

Snagging Cast Iron

The cast iron now being generally used for stove castings is hard and quite brittle. The castings are ground as they come from the foundry to remove the sharp fins and sprues. A grain 20 or 24 grade S Crystolon wheel gives excellent results.

Mounting and Fitting

For this work, where a somewhat better finish is required than for snagging and the wheel must hold the corner, a slightly harder acting wheel is required. Grain 30 grade S Crystolon vitrified wheels fulfill these requirements. Where a silicate wheel with wire web is required, a grain 24 grade T or U Crystolon wheel can be used. The wire web is specified by many as a safety precaution. It probably does keep the pieces from flying in case of breakage, but it also tends to weaken a wheel and from a safety standpoint good guards are better than the wire web.

Notching

For cleaning scale and excess metal from corners and slots of stove castings a grain 24 Alundum rubber wheel is almost universally used. There are exceptions of course where local conditions are such that finer wheels must be used. As fine as 60 grain wheels are being used in some plants.

Grinding out Cover Holes

For this work a cone wheel with the top cut off is used. The stove top is revolved on a horizontal table in contact with the cone running on a vertical spindle. Grain

20 and 24 grade S to U Crystolon wheels are used.

Surfacing

The stove tops are surfaced on automatic machines mounting several grinding and polishing wheels. The tops are bolted to the oscillating or revolving table and pass under roughing and finishing grinding and polishing wheels. For the roughing operation a grain 30 grade Q Crystolon wheel is often used and for finishing a grain 60 grade P or Q Crystolon wheel gives good results. Alundum abrasive grain set up on polishing wheels with glue is used for polishing. Any size required can be furnished and there is a wide difference in practice in the different shops. Number 36 or 46 can be called a good average grain for rough polishing and 120 for finishing.

Snagging Malleable Iron

For removing fins, sprues and irregularities from annealed malleable iron castings Alundum abrasive wheels are used. Grain 20 or 24 grade R or S wheels are rapid cutters and leave a sufficiently good finish.

Mounting and Fitting

As in the case of cast iron stove castings, a finer wheel is required when malleable iron stove parts must be fitted. Grain 36 grade Q Alundum vitrified wheels seem to be most generally chosen for this operation.

Notching

The same grain 24 Alundum rubber wheel used for notching cast iron stove castings is used for malleable iron.

Surfacing

An Alundum abrasive of special temper known as 66 Alundum gives better results on this work than regular Alundum. Grain 6624 or 6630 grade O and P wheels are used for roughing, and 6660 N or O are finishing wheels.

Alundum abrasive grain is used for the final polishing.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the
Grinding Industry that Have Appeared in
Recent Issues

Screw-Cutting Tool Grinding Fixture.

American Machinist, European edition, August 30, 1919, page 147E. A brief, general description of a fixture by means of which single-point screw-cutting tools can be ground accurately to desired angles, both cutting and clearance. This fixture is being supplied by the Coventry Gauge & Small Tool Co., Ltd., Earlsdon, Coventry.

Grinding High-Speed Steel Knives. Wood-

worker, September, 1919, page 49. A paragraph is devoted to each of the following subjects: Selection and care of grinding wheels; wet and dry grinding; cracks caused by hurrying the job; light or heavy cuts; proper knife bevels; jointing to a true-cutting circle; width of heel.

Machine for Grinding Button Dies.

American Machinist, September 25, 1919, page 609. Description of a machine built by the Locomobile Co. of

America, Bridgeport, Conn., to regrind the cutting edges of button dies. The first machine built has been in operation for over a year and has proved successful. The machine has been redesigned and the drawings turned over to apprentice boys. The patterns were made by apprentices in the pattern shop and the machine was built by apprentices in the tool-room. The machines marketed will be made by the apprentices.

Jig for Grinding Push-Rods. American Machinist, September 25, 1919, page 629.

Woods Plain Grinding Machine. Machinery, October, 1919, page 182. The Woods Engineering Co., Alliance, Ohio, is now building a plain grinding machine which is semi-automatic in its movements, the operator being merely required to set up and remove the work. The machine is styled a "wide-wheel automatic grinder."

In the operation of a grinding wheel, speed is the first factor to be considered. Overspeeding is dangerous, for the higher the speed at which a wheel is running, the less external force is required to break it.

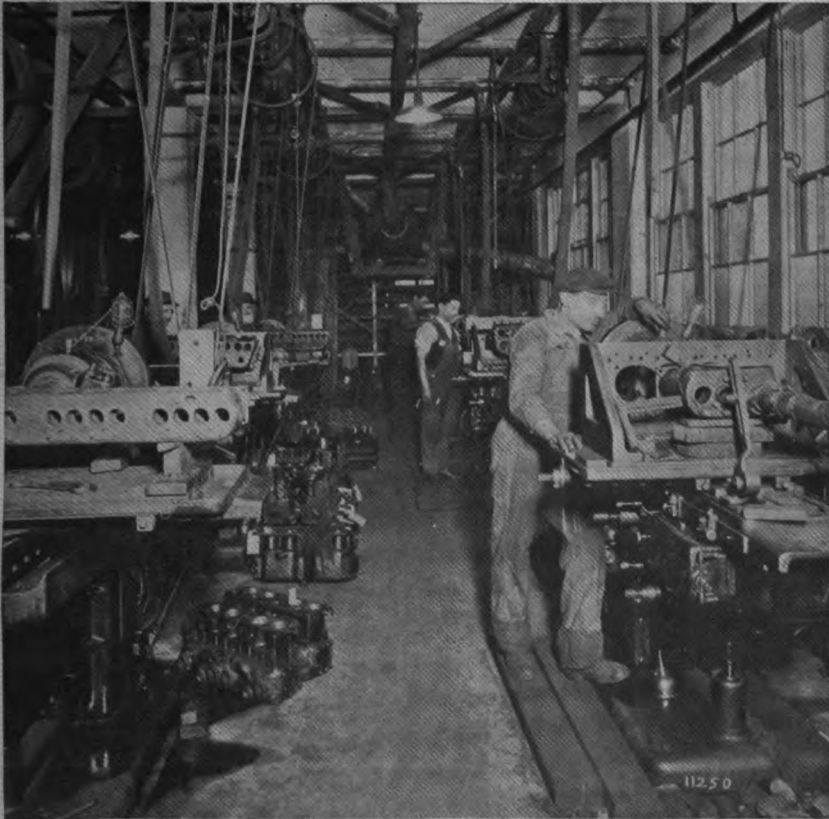
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GRITS and GRINDS

January



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Cylinder Grinding at the Houpert Machine Co., Long Island City, New York



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The Regrinding of Cylinders

**Some Questions Answered by the Houpert Machine Company,
Long Island City, N. Y.**

WHAT IS CYLINDER GRINDING? It is a highly perfected machine method of making cylinders round, smooth, and square with the base of the cylinder casting. It is the method that is used by a vast majority of motor car manufacturers and is conceded by engineers and practical mechanics to be the most highly perfected means of finishing the wearing surface of a cylinder.

HOW DOES REGRINDING CYLINDERS AFFECT THE POWER OF A MOTOR? Regrinding cylinders has a desirable effect on the power of a motor in that it restores the motor to its normal condition. A regrinding job gives the owner a seasoned motor not obtainable in a new car and one that has been assembled as an individual job rather than on a production basis.

HOW DOES REGRINDING AFFECT THE CONSUMPTION OF GASOLINE AND OIL? With loose pistons or improperly fitting piston rings it is possible for the gasoline to pass down into the crank-case before the explosion. It is often found that the gasoline and oil consumption is cut in two by regrinding and in most cases reduced 25 per cent.

WHAT IS THE DIFFERENCE BETWEEN REGRINDING AND REBORING? Boring or reaming is done with a cutting tool of steel. Grinding is done with a wheel of an abrasive material, revolving at a high speed. The construction of a cylinder casting is such that there are bound to be some spots of the metal harder than others. Therefore, when a cutting tool of any kind comes in contact with a hard spot, it jumps over; and when it comes to a soft spot, it digs in. This cannot be avoided. Therefore, any cylinder that is rebored by any process whatever is bound to have high and low spots. The disadvantage of a reaming process is the tendency of the reamer to follow the course of the old hole.

In grinding, the actual cutting is done by an abrasive wheel revolving at a very high speed on the end of a rigid spindle. The spindle at the same time moves in a circular path so that the revolving wheel travels around the hole. The path of the spindle is adjustable to the diameter of the hole. The work does not rotate, but is held securely on an angle plate which is fastened to the cross slide of the cylinder grinder. The table of the

grinder, carrying the cross slide, automatically travels lengthwise of the cylinder for the distance required in each specific case. When one hole is finished, the cross slide travels crosswise until it reaches the point desired for the next hole, and so on until the block is finished. The work on a set remains in place until finished, which insures the bores being parallel with each other; and there is no possible chance of their being out of line with the base. By this method, as the work is not rotated, there is no chance of its working loose from the angle plate and no danger of high or low spots, as it is a conceded fact that grinding is the only method of overcoming hard and soft spots and making a uniform surface.

[Acknowledgment is hereby made the Houpert Machine Company for the above material and the cover illustration.]

ARE REGROUND CYLINDERS AS GOOD AS A NEW BLOCK? Reground cylinders are better than new ones, not just as good. Cylinders that have been used at all have been subjected to such extremes of expansion and contraction that they have caused an annealing process; and it is, therefore, a seasoned casting, and a seasoned casting is unquestionably better than a new one. An old cylinder is like an old violin; so long as it works, no new one can be better.

IS THERE ANY SPECIAL MACHINERY NECESSARY FOR REGRINDING CYLINDERS? Special machinery is necessary in connection with cylinder grinding. The grinding itself should be done on machines made especially for this work, if the best results are desired.

The Importance of Accuracy in Cylinder Grinding

Although the importance of accurately ground cylinders has long been known to those experienced in the building of automobile motors and to the well-informed repair man, it is just beginning to be realized by the average owner.

In order that a motor may work properly and be correctly carburetted, the cylinders must be accurately ground so that the diameter does not vary more than .0005" as to roundness, and the hole must be straight and absolutely square with the base of the cylinder in order that the piston may be free to operate without being in a cramped position, in such a case inducing undue friction, noise, and danger of scoring.

In building a high-grade motor, the method of machining is first to bore the cylinder from the rough casting to within

.010" to .015" of the finished diameter and then to finish by grinding on one of the special cylinder grinding machines built for the purpose.

It is difficult and almost impossible to bore a cylinder from the rough casting so that the hole is square with the base, because of the tendency of the boring tool to follow the cored hole, and because the inaccuracy of the core invariably leaves the casting thicker on one side than on the other. The grinding wheel will straighten the hole and leave it square with the base, provided the grinding machine is of proper construction and rigid enough to handle the work.

Many of the lower-priced motors are built without the final operation of grinding the cylinders, reaming or lapping to make a finished hole being substituted



for the grinding. This operation leaves a smooth hole which may measure round, but which is usually not square with the base of the cylinder, and the relative efficiency of the motors thus produced depends largely on chance, as the cylinders may or may not be straight. This explains in some measure why cars of the same make and model are not parallel in performance.

Without an accurate, straight cylinder it is impossible to obtain good compression in a motor, because it is impossible to fit a ring to an out-of-round cylinder or to one which has been enlarged in the top, either by wear or by inaccurate machining. Not alone is the compression affected, but the leakage past the rings is more noticeable on the suction stroke when a certain amount of air is sucked up from the crank-case past the rings and into the combustion chamber, weakening the mixture and causing the motor to miss, especially at idling speeds. The first impulse of the driver, when this condition occurs, is to enrich the mixture, which overcomes the difficulty in a measure, but leads to more serious trouble. An excess of raw gasoline is thus introduced into the cylinder and works down past the rings on the compression stroke,

thinning the oil and destroying its lubricating qualities and possibly resulting in one or more scored cylinders. This gasoline eventually reaches the crank-case and mixes with the oil, thinning it to such an extent that it is useless for lubricating. This condition is not only found in motors whose cylinders are worn from use, but it is often present in comparatively new motors in which the cylinders have been inaccurately bored or reamed.

The popular remedy for this condition, once the car owner becomes aware that it exists, is to install a set of new piston rings, which usually aggravates the condition, because new rings require a long time to wear to a fit in an egg-shaped cylinder, and the only real cure is to send the cylinders to some reliable company which is equipped with accurate, special cylinder-grinding machinery and have the cylinders ground square with the base and fitted with new pistons and properly fitting rings. Care should be taken that the cylinders are not ground on a makeshift grinding machine but on a machine built for the purpose by manufacturers of long experience in making this class of machinery.

A grinding wheel should always be tapped lightly before mounting with the wooden handle of a hammer or screw driver to test the structure. A high, clear "ring" shows that the wheel is sound and fit for use ; a low, dead "ring" indicates that it has been cracked, probably in transit or storage.

Grinding Wheels for Augers or Bits

By P. N. COOKE

In the manufacture of augers or bits, grinding plays an important part in bringing about production, accuracy, and economy. From the time these tools leave the drop forge and the heat-treating room, the grinding wheel or set-up polishing wheel is depended upon to produce the finished product for the market.

Directly after forging, the grinding wheel is introduced. The operations are rather severe and call for wheels of hard grade. On the particular type of bit illustrated in figure 1 there are three principal

required shape. Occasionally, dressing will be necessary to retain this shaped face.

After this initial grinding process, the bit is hardened and tempered. On account of the heating and sudden cooling from these processes, there usually occurs slight warping. This condition is remedied by succeeding grinding operations. Off-hand grinding of the "twist" is accomplished by the use of a rubber wheel of grain size 60 or 70. The surface ground is represented by "C" in the first illustration. By selecting a wheel

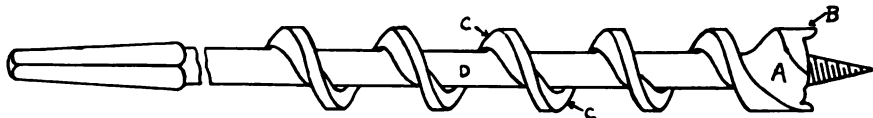


Figure 1

operations involved, employing the solid grinding wheel.

"A" represents the cutting surface of the bit after the screw has sunk deep enough to permit the lips "B" to bite the stock. The die used in the drop forge is designed to leave considerable metal in this part of the bit, in order that the wheel may leave a sharply defined groove and cutting edge. The wheel for this work

of the proper thickness to accommodate the size of bit ground, the experienced operator is able to produce a finished concave surface, extending from the periphery of the bit to the web, without leaving any shoulder at the center. The bit is revolved by hand and held against the formed face of the wheel, at the same time traversing to accommodate the "pitch of the helical flutes."



Figure 2

should be applied while the steel is soft, having first been annealed after forging.

An Alundum rubber wheel in 36 or 46 grain, made in varying thicknesses to care for different sized bits, has been found very well adapted for this operation. With this wheel the excess stock is readily removed with one cut, the wheel being the exact width of the groove and the face formed to a templet to give the

For a commercial finish to make the product marketable there remains to be ground the cylindrical portion of the web designated by the letter "D." This is accomplished by a cylindrical operation, the bit revolving on centers and traversed automatically by a wide Alundum rubber wheel, the thickness being determined by the distance between the "twists." The specifications for this



work favor the Alundum rubber size 70 grain.

The 60 or 70 Alundum rubber wheel is also used on a third type of bit not illustrated, but which is similar to figure 1 with the exception that the web is omitted and the "twists" are closer together. The foregoing describes somewhat in detail grinding methods which are followed in the manufacture of two very popular styles. There is another type, represented by figure 2, which requires a somewhat different procedure.

For the cylindrical grinding of this bit, it is sometimes the practice to utilize the sandstone. In a recent test of large Alundum wheels 40" in diameter

by 6" thickness, it was demonstrated that where a sandstone was entirely consumed, the Alundum wheel wore only a fraction of an inch on the diameter. This would favor its use, taking into account the difference in first cost.

Other problems met in grinding these tools will be found peculiar to each manufacturer. These can best be handled by considering each problem individually.

For producing the final polish, leather-covered wood wheels when properly mounted with TJ Alundum grain in sizes from 70 to 90 will be found to give maximum satisfaction when cost and production are taken into consideration.

A Few Causes of Feed Lines

By C. H. NORTON

[The following is the stenographic report of some interesting informal remarks by C. H. Norton, in answer to the question, "What Causes Feed Lines?" which was put to him during a recent sales conference.]

Although we probably will never succeed in entirely eradicating the spiral or feed lines of a wheel on commercial cylindrical work, a few reasons why they appear may be of interest.

Table Traverse

It is impossible, of course, to feed a wheel an amount exactly equal to its width for each revolution of the work. It must ride a little. In other words, the screw pitch, the lead, is a little less than the width of the wheel. What happens? There is a certain part of the work which the wheel goes over twice. Therefore, the little grain marks look different in that part. You will never eradicate that—the wheel goes over there twice, and those grain marks will always be a little different looking than the rest of the piece.

Machine Spindle

If the spindle of the machine is not exactly parallel with the traverse of the table on the ways (if you want to be very careful as in grinding big rolls or

anything of that kind), you must place your diamond exactly in the same plane as the axis of the spindle and the work. Then the face of the wheel will be exactly parallel with the traverse. For instance, if your spindle was tipped up say 3" or 4" and the wheel was trued across the top, you would have a cone. But if you true it with a diamond in the same plane as the two axes of the work and spindle, then the face of the wheel must be parallel with the face of the work and, therefore, that cause for spirals or feed lines is eliminated.

Wheel Dressing

The diamond in Norton cylindrical grinders is held slightly above the center for convenience, and we do not always have to take the work out. When truing a reasonably wide wheel with a diamond, of course you want to use a copious supply of water. You do not want the diamond to get red hot, but if the water does not touch every spot on that wheel, the place where it does not touch will be a different

diameter than the rest of the wheel. This will cause feed lines.

Hard Wheels

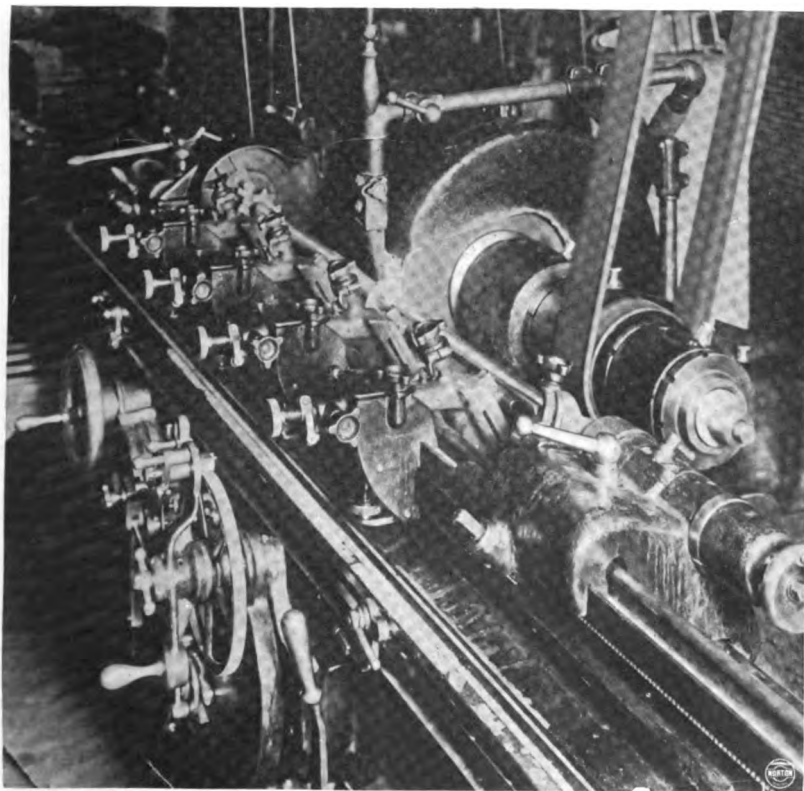
If a wheel is used that is too hard, it will separate the axis of the work and wheel slightly, say .00001"; and as the wheel drags along by, of course it will leave a mark. If the axis of that work separates from the wheel, or you bend the work .000001", you will see that line in the finished work when it is completed. If you use a very soft wheel, this cause of feed lines will be eliminated. You can grind and make work look beautiful, if you do not want too high a finish.

You must be careful; you must use good steady rests without springs. You

must true the wheel carefully, having every bit of it wet, and you must listen to that wheel as you would when you listen to any sound. The sound of the dressing must be uniform clear across the wheel, or feed lines will be caused.

As a matter of fact, feed lines do not affect the accuracy of the work. They cannot be measured, and the only difference is in the appearance. If two shafts are lapped, one having feed lines and one without feed lines, there is no difference in the finished shaft.

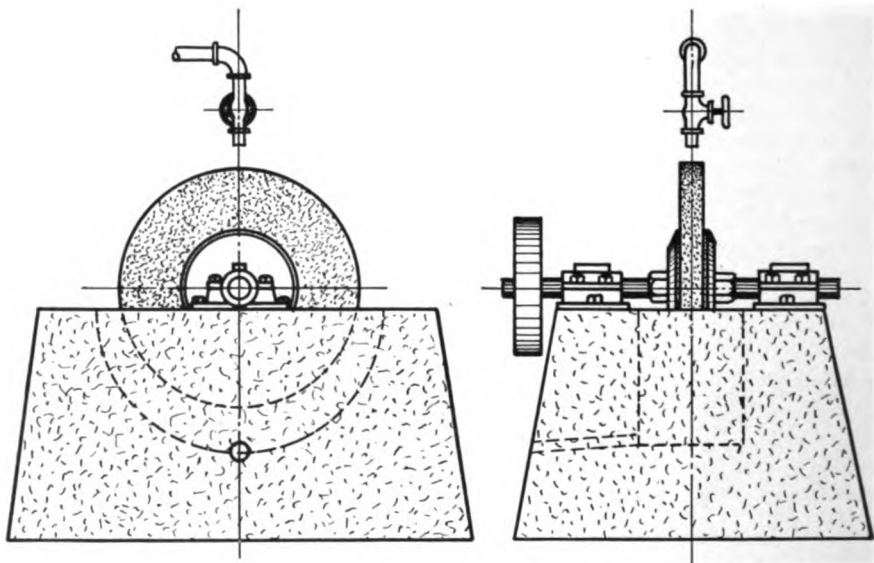
The one important thing to bear in mind is that feed lines affect only the looks, the accuracy being unaffected.



Illustrating the Proper Use of Steadyrests



Grinding Wheels for Use in Slaughter Houses



Floor Stand for Grinding Butchers' Knives and Cleavers at the Plant of Nuckolls Packing Company, Pueblo, Col. These views do not show wheel guard

The growing scarcity of good sandstone wheels and the marked variation of those which can be obtained had led many firms to investigate the possibilities of Alundum wheels on work where they were convinced only sandstone could be used to practical advantage. In many cases the results have shown a marked improvement in production and quality of work. Longer life in the wheel has also materially reduced the grinding cost per unit.

Slaughter houses have had this experience and the arrangement in use at the plant of the Nuckolls Packing Company at Pueblo, Colo., is typical of a satisfactory and efficient device for grinding butchers' knives and cleavers.

As shown in the accompanying sketch this stand is made of reinforced concrete and has a well and drain in the base. The spindle was made from $2\frac{1}{4}$ " shafting, ring oiling pillow blocks being used for mounting it. Flanges of 14" diameter are provided.

An Alundum silicate wheel $3 \times 2\frac{1}{4}$ ", 46 L, is used and run at 450 r. p. m. or approximately 3,600 s. f. p. m. Water is piped direct to the wheel at city service pressure.

Two men are able to use the wheel at the same time—one from each side. Knives are ground with the wheel running from the operator; cleavers, however, are

ground with the wheel coming towards him. This work is done from five to six times as fast as when sandstone was used and no tendency to burning has ever developed.

The arrangement illustrated in this article can be installed for about \$50 and can, as in the case of Nuckolls Packing Co., be made in the shop with very limited facilities at hand.

Notes from the Files of the Sales Engineering Department

Duriron

Duriron is the American silicon iron developed within the last 8 or 10 years particularly on account of its acid-resisting properties. It is coming into use quite extensively as an excellent material for acid containers, pipes, condensers, pumps, electrodes, fittings, and all acid-proof apparatus. Thus the use of rare, expensive metals is being gradually eliminated in favor of this silicon iron.

In appearance duriron is a silver-white, close-grained cast iron. It may be cast into any shape desired. It is extremely hard and cannot be machined. There is a special brand of this silicon iron, however, that is soft enough to be machined.

This material may contain up to 15% or even more silicon, with usually less than 1% each of carbon, manganese, and phosphor. The distribution of these constituents directly affects the properties of the alloy and they are manipulated to produce any brand of silicon iron desired.

It is slightly inferior to cast iron in density, tensile strength, transverse strength, crushing strength, and heat conductivity. It is harder than cast iron and very much superior in resistance to

corrosion. The comparison in the last case is said to be about 1,000 to 1.

Since it is too hard for ordinary machining, the grinding wheel is naturally used in removing all surplus material from the casting and also for shaping or working the material. Tests have been made to determine the most efficient grain, grade, and kind of wheel. The following is a brief summary of the general results from these tests:

Cylindrical grinding—36-K to N Crystolon vitrified; 46-J to N Crystolon vitrified;

Internal grinding—36-K to O Crystolon vitrified; 46-K to Q Crystolon vitrified;

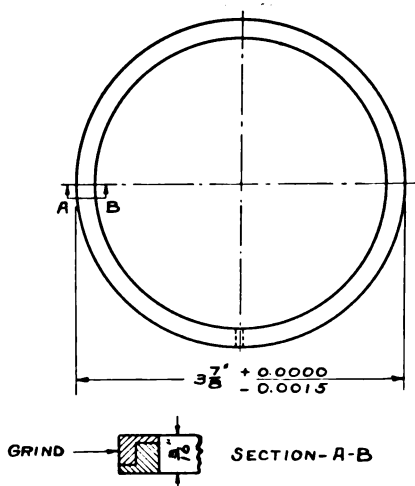
Surface grinding—36-J Crystolon vitrified;

Off-hand grinding—20-P to Q Crystolon vitrified; 24-P to Q Crystolon vitrified.

The grain and grade for these various operations depend largely on the size of wheel being used, the type of machine, and the surface desired, but the foregoing have proved very generally satisfactory. Thus it will be seen that duriron can be ground successfully with the same grains and grades as would be used for cast iron.



The Photograph shows an Alundum 10" x 1" Wheel, Grain 20, Grade P, Finishing the Fishing Section of Rail on a Solid Manganese Frog to Match the Exact Contour of the Rail to Which it Connects.



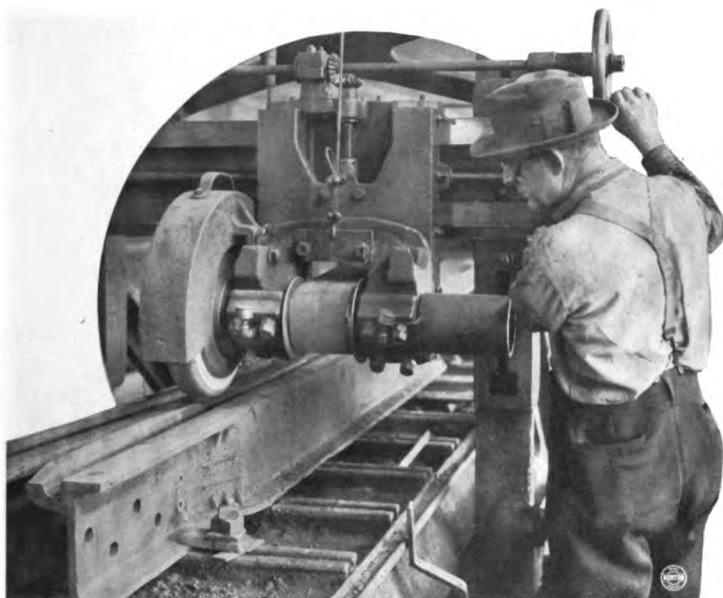
EXAMPLE OF PISTON RING GRINDING ON A NORTON MACHINE WITH AN ALUNDUM WHEEL.

Production, 5,000 in ten hours.

Stock removed, .035".

Limits, standard to .0015 small.

Ground on arbor, 26 at a time.



Grinding the Top Surface of a Street Railway Tongue Switch, Manganese Steel, with a Special "Planer Grinder." The Wheel used is Alundum 18" x 2½", Grain 16, Grade P, and $\frac{1}{8}$ to $\frac{1}{4}$ is Removed at 1,800 R.P.M.

When a wheel doesn't slide onto the arbor easily, don't force it. If the hole is too small, enlarge it slightly. This can be done with a knife or file where the hole is lead bushed; with a piece of wheel or abrasive brick where there is no lead bushing. To force the wheel on the arbor is likely to cause breakage.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

Grinding Molding Bits. Wood-Worker, November, 1919, page 32. The writer emphasizes the value of selecting carefully grinding wheels for this work.

Reclaiming High-Speed Precision Cutting Tools from Scrap Heap. Iron Trade Review, November 20, 1919, page 1379. This article gives an account of the work done by the Grinding Process Tool Co., 810-820 West Warren Avenue, Detroit. This company remanufactures cutting tools which were sold formerly as scrap or junk. Its process is entirely one of grinding. Often distinctly different tools from the worn-out ones are manufactured. Except when the customer gives the company right of way to use its own judgment in making up new tools which it can use from the worn-out tools sent in, an effort is made to follow specifications or blue prints.

Grinding the Cutters of the Patent Drill. Machine Tool Review, August, 1919, page 149. The fixture can be used on any cutter grinder. "It consists of a housing carrying a spindle bored taper to receive the various adapters which carry the cutters, and which are practically short unfluted drill bodies. The fixture is supplied with six interchangeable adapters, which enable it to handle all sizes of cutters from 1½ inch to 3 inches inclusive."

Internal Grinding in Locomotive Shops. Machine Tool Review, August, 1919, page 150. A general discussion of the various operations for which grinding machines are used in the locomotive shop.

Methods of Grinding in a Lathe. American Machinist, November 13-20, 1919, page 860.

New Face Grinding Unit Is Self-contained. Iron Trade Review, December 4, 1919, page 1520. Description of a new face grinding machine developed by the Cleveland Machine Tool Co., Cleveland, Ohio.

Lafayette Portable Universal Grinding Machine. American Machinist, November 13-20, 1919, page 897. "This machine manufactured by the Lafayette Tool and Equipment Co., Lafayette, Ind., is particularly recommended by the makers for threaded work—internal and external. It is said to grind to within .0001 inch all types of gages, taps and dies, reamers and cutters, etc. It is capable of grinding holes as small as ⅜ inch in diameter by 8 inches in length. It is possible to obtain any angle desired as the machine is adjustable horizontally 3½ inches, vertically 2½ inches, and angularly to 20 degrees, these adjustments being regulated by micrometer readings graduated to .001 inch."

Grinding Spherical-Ended Gauges. American Machinist, European edition, October 11, 1919, page 32E.

Safety in Grinding. Foundry, November 1, 1919, page 799. Two attachments for use with an ordinary foundry stand grinder are described in this article. One is an adjustable sliding table which is set immediately in front of the two wheels of a double stand grinder. The other device is a glass shield which is attached to the wheel guard and which is intended to be used with or without goggles to guard the workman's sight.

Ott 6 x 6-inch Internal Grinding Machine. American Machinist, October 23, 1919, page 771. Description of a machine made by the Ott Grinder Co., Indianapolis, Ind.

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GRITS and GRINDS

FEBRUARY 1920



Grinding Manganese Steel Castings



Grits and Grinds

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Manganese Steel Grinding

By R. M. JOHNSON

Alloy steels are interesting, not only because of the large number of different combinations of properties that can be obtained, but also because of the increased efficiency of these comparatively new steels. Carbon steel is really an alloy steel, but when we refer to this class we mean steel to which has been added some of the less common metals such as tungsten, vanadium, molybdenum, nickel, manganese, and chromium. Possibly not the most important, but surely one of the most interesting of these, is manganese steel containing from 12 to 14 per cent manganese.

This steel, although discovered by Robert Hadfield in 1886, did not come into prominence until about twenty-five years ago. And it was even later when its great commercial value was realized. Up to the time it was discovered, all metals that were hard enough to resist abrasive wear were so brittle that they could not be used for many parts. Chilled iron is very hard, but very brittle and comparatively weak. Hardened tool steel is stiff and easily broken under shock. Manganese steel is hard and also very tough.

This property of toughness with hardness is obtained only after the manganese

steel castings are heat-treated. When cast and allowed to cool slowly the castings are hard, but also very brittle. After removing from the molds the castings are heated and quenched in cold water. The resulting casting is hard, tough, and so malleable that it can be drawn into wire, rolled, and forged. When in the brittle unannealed condition, the risers and sprues can be broken off. After annealing, the castings cannot be commercially machined with any steel tool now known, but must be ground. If a keyway is to be cut or a hole tapped, soft steel inserts are set in the molds and the metal cast around them.

A typical analysis for manganese steel is

Carbon,	1.25%
Silicon,	.30%
Manganese,	12.50%
Sulphur,	.02% and less
Phosphorus,	.08%

The uses for manganese steel are practically without limit. In general where moving parts are constantly exposed to gritty dust, manganese steel castings give excellent service. Possibly an enumeration of some types of machinery in the construction of which this steel is used will be interesting; crushing and pulverizing machinery for ores, coal, slag, and cement; clay working machinery;



Figure 1. An excellent installation of swing frame grinding machines. These machines have universal movement because of suspension from one point

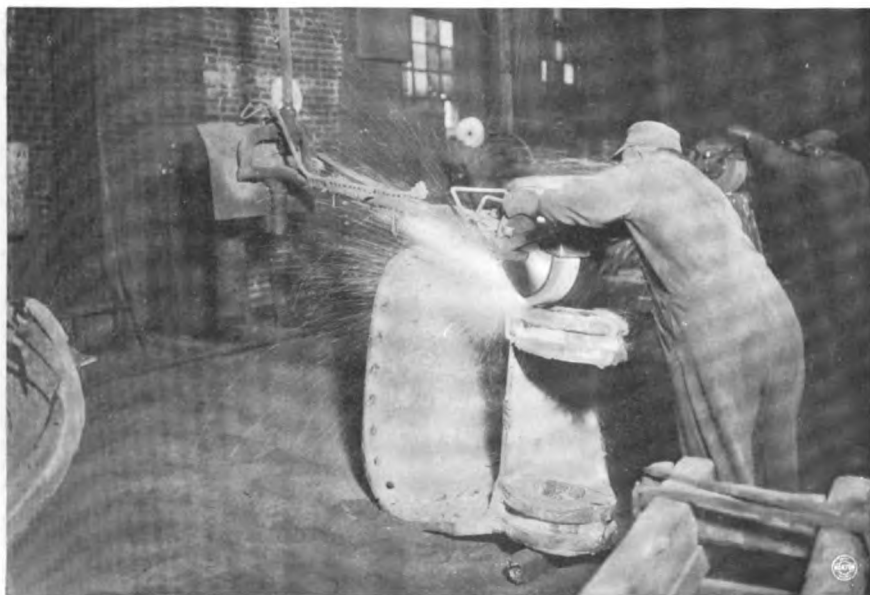


Figure 2. Giving a close-up of one of the above swing frame machines. The operator is snagging a gold dredge bucket

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Figure 3. Snagging a crane wheel with an Alundum vitrified wheel

emery mill rolls; buckets, chain, and sprockets for bucket elevators; corrugated rolls, segments, gears, and pinions of coal crushers; carrier wheels, sheaves, and idlers for wire ropeways; wearing parts of steam shovels, dredges, and ditching machinery; and centrifugal pumps. Manganese steel is also used for crossings, frogs, switches, and guard rails; for tractor links and sprockets; for gears and pinions commonly used in steel mills; and for safes.

An enormous increase in life of the various parts is noticed when manganese steel is substituted for cast iron, chilled iron, malleable iron, and ordinary open hearth steel. Some interesting comparisons have been made. Jaw plates of a rock crusher made of manganese steel give four to six times as long service as chilled iron plates. Manganese steel chains show five to fifteen times the life of malleable iron chains and a working

strain of over 50 per cent greater with equal safety. Casings of centrifugal pumps used for dredge work show three to six times the life of ordinary steel. Revolving rock screens made of ordinary steel have to be changed often because the holes enlarge. With manganese steel plates this is not the case and they last eight to ten times longer.

In connection with the use of manganese steel sheaves an important property is brought to light. Cast iron sheaves require frequent renewal. Particles of grit become imbedded in the groove, metal particles work into the rope, scoring the groove and in time cutting the rope. Manganese steel sheaves wear smooth and as a result the ropes sometimes last 100 per cent longer. Because of the increased strength the sheaves many times can be made 30 to 50 per cent lighter in weight.

From the discussion above, it is no doubt



Figure 5. Grinding pipe balls with an Alundum wheel—a very severe operation

For snagging operations such as these, the grinding wheel must be free cutting. At best, considerable heat is developed when manganese steel is ground; slow cutting wheels increase heat and increase

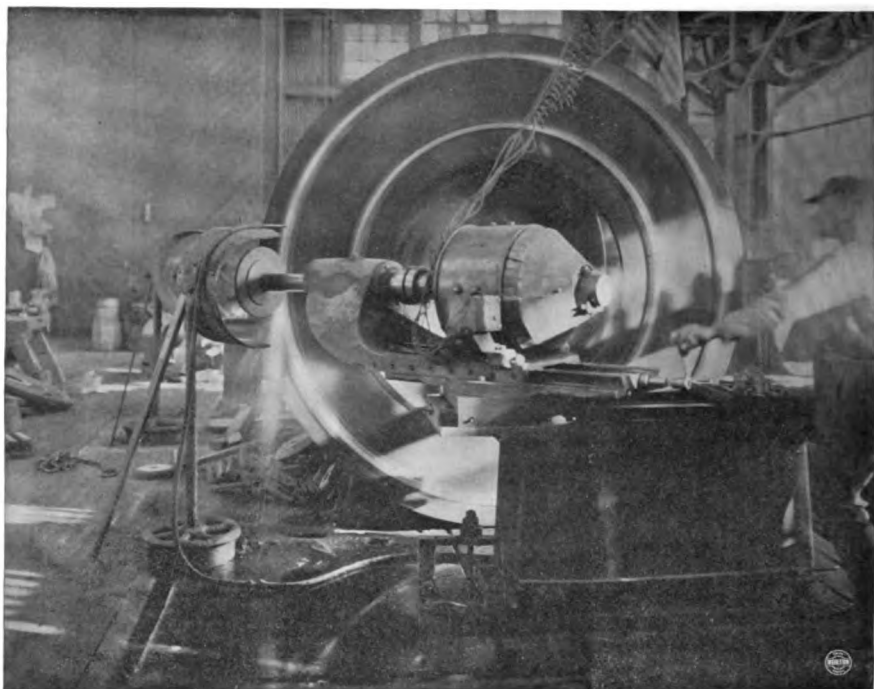


Figure 6. Suction side liner, 8 feet $7\frac{1}{8}$ inches diameter, for a centrifugal pump being ground on a special lathe with an Alundum vitrified wheel

the possibility of breakage. Hard wheels heat and cut slowly; soft wheels are cool cutting, grind rapidly, and of course wear faster than the hard wheels. There is a grain and grade which gives maximum results when considered from all angles.

A cylindrical grinding machine used for finishing the periphery of crane wheels is shown in figure 4. An 18 x 2 x 8, grain 30, grade N, Alundum vitrified wheel running at about 6,500 s. f. p. m. is used. The work revolves at 32 r. p. m., a surface speed of 100 feet per minute. A fillet is ground on both sides of the tread, the wheel being fed straight in.

Figure 5 shows another cylindrical operation, grinding pipe balls. The

wheel speed is 6,500 s. f. p. m., work speed 200 s. f. p. m., feed .010 inch, table traverse 108 inches per minute. The part ground is 11 inches diameter by 6 inches long. This operation is very severe on the grinding wheel; it must cut rapidly or the wheel wear is excessive. A 20 x $2\frac{1}{2}$ x 8 inch, grain 6630, grade Q Alundum vitrified wheel is used.

A special lathe which can be rigged for all kinds of work is shown in figure 6. The picture shows an 8 foot $7\frac{1}{8}$ inch diameter suction side liner for a centrifugal pump being ground with a 14 x 2 x $1\frac{3}{4}$ inch grain 24, grade M Alundum vitrified wheel. A work speed of 300 feet per minute is used.

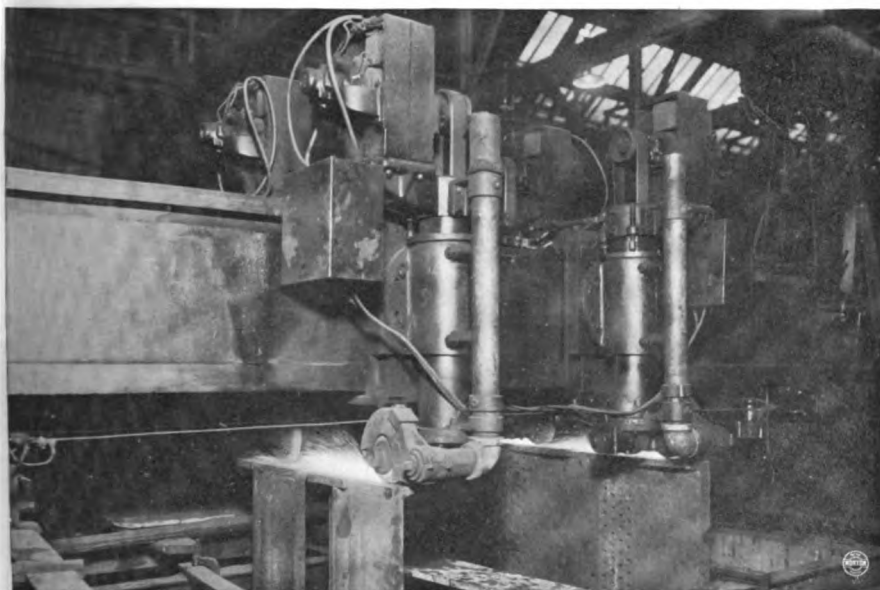


Figure 7. A pit grinding machine, mounting four Alundum wheels, shown grinding the ends of ball mill plates used in a cement grinding machine



Figure 8. Surface grinding machine—planer type. Surfacing crusher segments with an Alundum vitrified wheel

[FEBRUARY, 1920]

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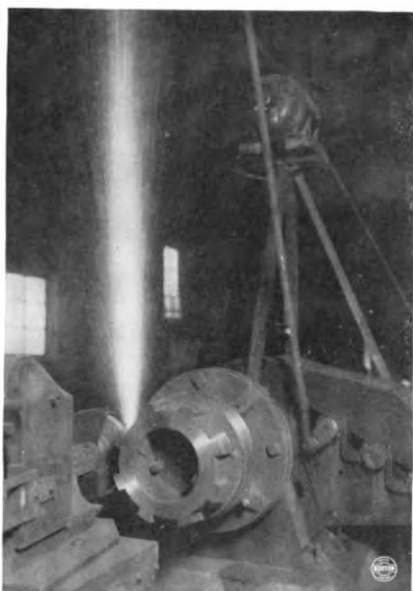


Figure 9. Special lathe for grinding safe doors

Figure 7 is a specially designed machine for surface grinding and is called a pit grinding machine. It mounts four 10 x

$1\frac{3}{4} \times 1\frac{1}{2}$ inch, grain 24, grade M, Alundum vitrified wheels. The picture shows the machine being used for grinding the ends of ball mill plates used in a cement grinding machine. The traverse is 144 inches per minute.

Another surface grinding machine, a planer type, is shown in figure 8. It is being used here for surfacing crusher segments. The wheels are $10 \times 2 \times 1\frac{1}{2}$, grain 24, grade M, Alundum vitrified. The table traverse is 240 inches per minute.

The manufacture of manganese steel safes is an interesting process. The rough castings are snagged in the cleaning room. The door hole in the safe is ground internally on a lathe. Figure 9 shows a special lathe used for cylindrically grinding the safe doors, where a $12 \times 1\frac{3}{4} \times 1\frac{1}{2}$, grain 24, grade M Alundum vitrified wheel is used. The work speed is about 20 feet per minute. After the door and the door hole have been ground to practically the same size, abrasive grain mixed with oil is placed on the bearing surface and the door lapped in until the safe is absolutely air tight.

NOTE: We are indebted to the Taylor-Wharton Iron and Steel Co., High Bridge, N. J., for the pictures illustrating this article.

The popular idea that the work speed once established for any one piece of work will always be suitable for duplicates is erroneous. The art of quickly finding the best cutting speed for the work makes for a large part of the operator's success in producing a large amount of good work, and in prolonging the life of the wheel.

Notes from the Files of the Sales Engineering Department

How to Order Grinding Wheels

Prompt shipment of grinding wheels is possible only when we are able to enter your orders immediately after they are received. More delay is caused by failure to put all of the necessary information on the order than by any other one cause. When an order is received without complete information it is necessary for us either to write to you or to search through our records to determine whether you have ever had a similar wheel. In most cases we have to write.

Wheels ordered belong to two general classes: those that have been used before and are being reordered and those that are being ordered for the first time.

Reordering

To fill an order intelligently we must know the size of the wheels required, the shape and face, the grain and grade, abrasive and process. When reordering, if the Norton order number of the last wheels shipped can be given, this is an added check on the specifications and is of a great deal of assistance to us.

Dimensions

Complete dimensions must always be given. These should always be given in the order, diameter x thickness x hole size. *Straight wheels* need only the three dimensions, such as 16 x 2 x 2". (See figure 1.)

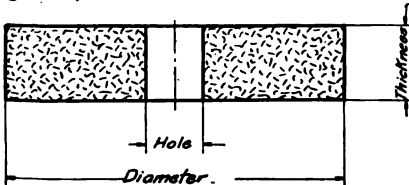


Figure 1

Cup wheels should have in addition the rim and back thickness given, for instance, 4 x 2 x 3/4", 1/2" rim, 1/2" back. (See figure 2.)

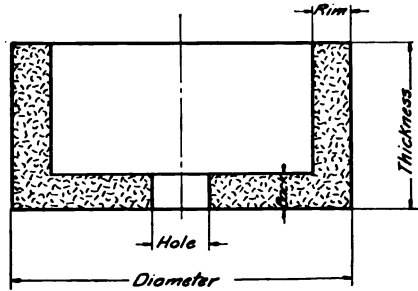


Figure 2

If the cup is tapered, the two diameters are given as a fraction, as (4-3) x 2 x 3/4", 1/2" rim, 1/2" back. (See figure 3.)

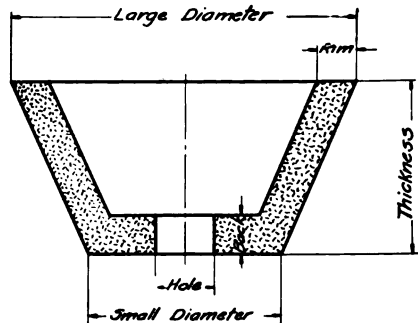


Figure 3

Cylinder wheels should have the rim thickness substituted for the hole size, 18 x 5", 1½" rim. (See figure 4.)

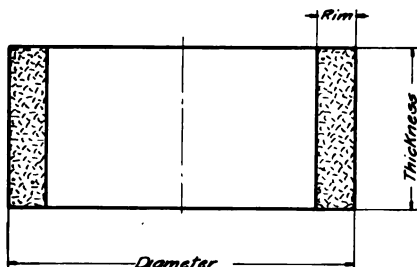


Figure 4

Recessed or countersunk wheels should have the diameter and depth of the recess specified, 18 x 2 x 5", countersunk one side 8½ x ½". (See figure 5.)

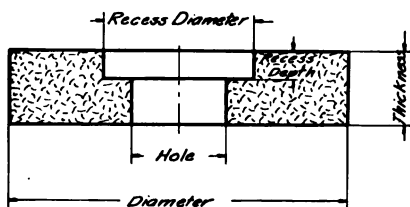


Figure 5

Shape

Whenever a shape other than a straight wheel is wanted this must be specified. The common shapes are listed and illustrated in our catalog. If we receive an order for a wheel 6 x ½ x 1¼", a straight wheel would be shipped. A Norton No. 10 dish wheel has the same specifications, but in addition to the dimensions, Norton shape No. 10 must be specified if this dish shape is wanted. If you cannot find a wheel of the shape wanted in the catalog send in a sketch with complete dimensions as shown in figure 6.

When no face is specified a straight A face wheel is furnished. The different faces which are regularly furnished are specified by letters as shown on page 11.

[10]

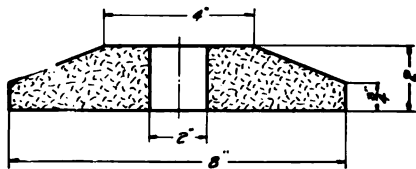


Figure 6

Grain and Grade

Grain is specified by a number which gives the size of the grain used in the wheel. Number 30 means grain that will pass through a screen having 30 meshes to the linear inch or 900 per square inch.

Grade is the term used to denote the hardness of a grinding wheel. It actually represents a measure of the strength of the bond or the holding force exercised by the bond to retain the grain in the wheel. For vitrified and silicate wheels it is specified by a letter ranging from the softest wheel F to the hardest Z. For elastic wheels a number is used, grade ¾ being the softest and grade 7 the hardest.

A grain 30 grade M wheel is one made of No. 30 grain in grade M hardness.

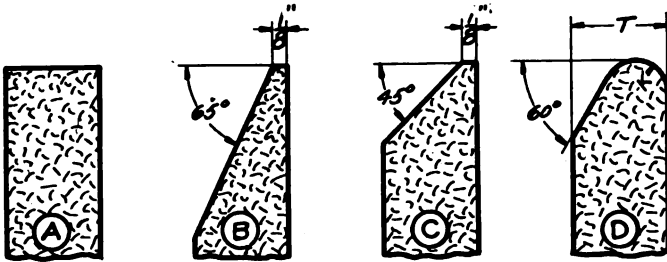
Abrasive and Process

We have two kinds of abrasives, Alundum and Crystolon. Alundum is made in three tempers: regular, No. 66, and No. 38. If no mention is made of abrasive we assume that the wheels are to be made of regular Alundum abrasive. If No. 38 and No. 66 Alundum abrasives are wanted, they must be specified (except where we know that these two abrasives give best results). They are specified by the figures 38 or 66 given before the grain size such as 3830 or 6630.

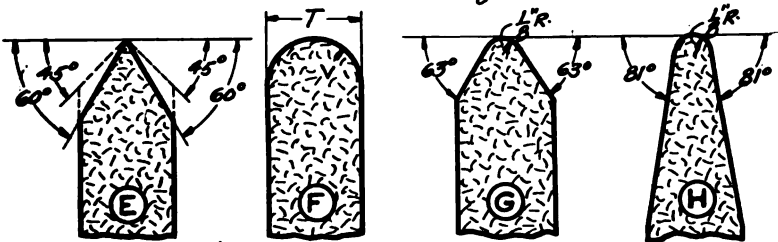
Crystolon must be specified by using the word Crystolon.

Norton wheels are made by four processes: vitrified, silicate, elastic, and rubber. When no process is specified we assume vitrified is desired unless, of course, the grade is given as a number when elastic wheels will be furnished. If silicate or rubber wheels are required, this must be specified.

[FEBRUARY, 1920]

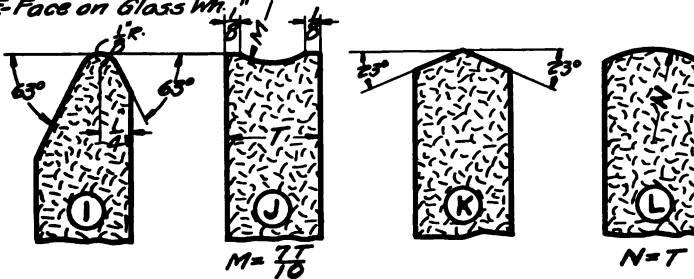


On small B-Face wheels
leave a small flat surface
around hole and bevel to $\frac{1}{8}$ " at face.



Dotted lines show
angle of bevel for
E-Face on Glass wh.

$$L = \frac{T}{2}$$



$$M = \frac{T}{10}$$

$$N = T$$

Figure 7

When New Wheels Are Ordered

When ordering wheels for a new operation, be sure to give the size and shape wanted. If in doubt about the proper grain, grade, abrasive, and process, allow us to specify. To do this we must know the details about the operation: the shape, size, and kind of material, what the

operation is, whether cylindrical, internal, or surface grinding, amount of stock to be removed, the wheel and work speed, whether wet or dry grinding will be employed, finish required, and any other factor that will be of interest to us. Better still, fill out in detail an information blank which we will be pleased to send to you upon request.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

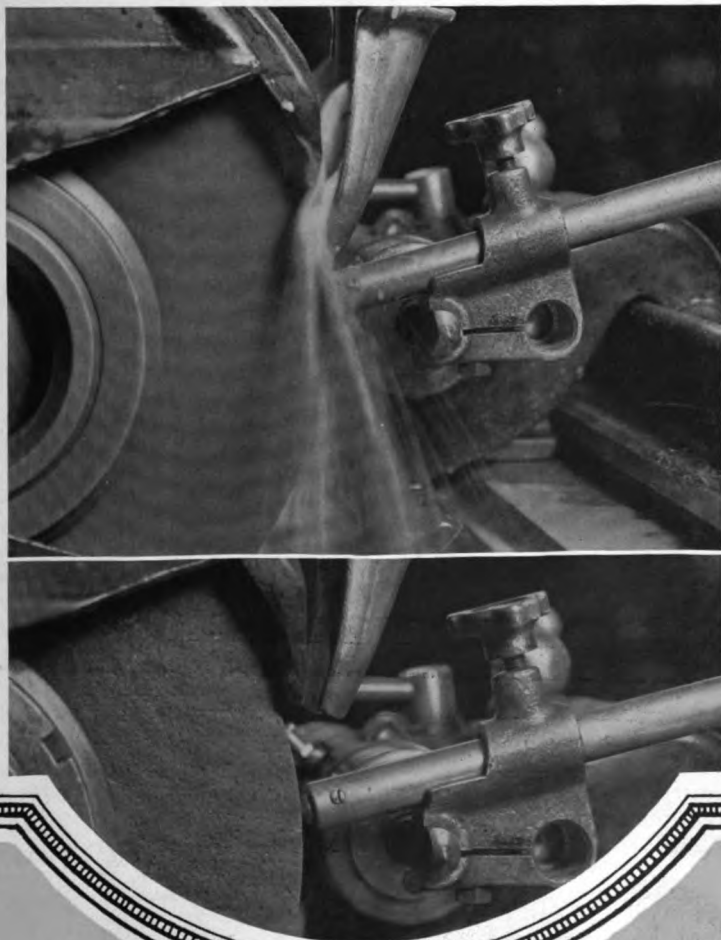
- Surface Grinder for Moulding Boxes. American Machinist, European edition, November 22, 1919, page 83E. "S. Holmes and Co., Bradford, have recently produced a vertical surface grinder, the immediate purpose being for grinding moulding box faces. The cup wheel carried is 14 in. diam. by 4 in. deep running at about 1,400 r. p. m., the drive to the spindle being by 3½ in. belt."
- Grinding 45° Side Milling Cutters. American Machinist, European edition, November 22, 1919, page 88E. The writer of this article advocates the use of a plain wheel on a surface grinding machine when grinding cutters instead of a cup or saucer wheel. He claims that the advantages are a straight relief and a better finish.
- Trolley Wheel Grinding Fixture. American Machinist, European edition, November 22, 1919, page 88E. Description of the fixture and its operation in grinding trolley wheels. This appliance was only experimental, but it has proved quite satisfactory.
- Polishing Methods. Machinery, November, 1919, page 203. This article gives detailed information concerning the wheels, belts, and abrasives used in polishing operations.
- Precision Thread Grinder. Machinery, November, 1919, page 278. Precision and Thread Grinder Mfg. Co., 1932-1934 Arch St., Philadelphia, Pa.
- Lafayette Universal Grinder. Machinery, November, 1919, page 279. Made by the Lafayette Tool & Equipment Co., 21 South 12th Street, Philadelphia, Pa.
- Ott Internal Grinding Machine. Machinery, November, 1919, page 284. The Ott Grinder Co., 217 West 10th St., Indianapolis, Ind., is now building for the market a 6- by 6-inch internal grinding machine. This new machine is described at length in this article.
- Large Castings finished by Grinding. American Machinist, November 27-December 4, 1919, page 913.
- Details of Shaving Dies. American Machinist, November 27-December 4, 1919, page 929. The concluding paragraph of this article tells how the dowel pins used in these tools are finished by grinding.
- Exhaust Hoods for Grinding Machines. American Machinist, November 27-December 4, 1919, page 947. "This article shows how hoods were installed in a toolroom in such a manner as to interfere as little as possible with the operation of the machines."
- Dunham Motor-Driven Valve-Grinding Machine. American Machinist, November 27-December 4, 1919, page 963. "A bench grinding machine designed primarily for valve facing has been introduced by D. F. Dunham, 830 West 37th St., Los Angeles, Cal.
- Grinding Machine Knives. Wood-worker, December 1919, page 29.
- Setting Diamond for Wheel Dressing. American Machinist, December 11, 1919, page 999. The writer describes his method of holding the diamonds which he has used successfully for many years.
- Driver for Grinders and Lathes. Machinery, December 1919, page 329. "The driver or chuck which is here illustrated was designed for revolving work held between the centers of a lathe grinding machine. The special feature of this device is that it permits the insertion and withdrawal of the work while the machine is in operation. The construction of the appliance is clearly shown in the illustration."
- Grinding Surfacers and Jointer Knives. Machinery, December 1919, page 313. "A novel method of grinding surfacer and jointer knives is employed in the carpentry and machine departments of the Danbury Trade School, Danbury, Conn."

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GRITS and GRINDS

MARCH 1920

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Commercial Diamonds For Truing Grinding Wheels

By W. R. MOORE

The problem of selecting the proper type of commercial diamond best suited for truing modern grinding wheels is one of great importance to all concerns where any form of precision or tool room grinding is practiced. This discussion on the subject has been outlined from results of our own experience and the experience of several of the leading industrial diamond companies of the United States.

Origin

The two principal sources from which diamonds are obtained are:

- (1) South Africa
 - (a) Brown Bort (Premier, Jaegers Fontain)
 - (b) Grey Bort (Premier, Jaegers Fontain, Bulfontain, River Stones)
 - (c) Ballas (Grey and Black)
- (2) Brazil
 - (a) Brazilian Bort
 - (b) Brazilian Ballas
 - (c) Carbon (Black Diamonds)

Classification of Stones

African brown bort, grey bort, and ballas stones are probably the most widely used of all types. The estimate is made that approximately 85% of the factories use these stones, which should

indicate that they render the best average service and are most economical to use.

Brown bort and grey bort are somewhat cheaper than the ballas stones and give excellent service, but for some classes of work the ballas stones are reported as being far superior.

The word "ballas" is only a Dutch word meaning round, although the "ballas" stones are also exceptionally hard. The word "Premier" signifies that these diamonds come from the Premier mine in South Africa. "Jaegers Fontain" and "Bulfontain" also signify the names of the mines in South Africa.

The opinion generally prevails that every bort diamond is imperfect. This may, to some extent, be misleading. Diamonds are mined primarily for the production of gems, but a large portion of the stones are unsuitable for this purpose for the following reasons:

(1) Some diamonds have cross-grain or ballas formations and are therefore too hard to cut.

(2) Some diamonds contain a number of black carbon spots, thus making imperfections in the gem.

(3) Diamonds of a brown, grey, black, or cloudy white appearance are of little value for gems.



All of the above classifications are sorted from those suited for gems and are used for mechanical purposes. The finest grades of this classification are recommended for truing grinding wheels.

Color

The color of diamonds runs from pure white through various shades of greyish leaden white, blue, green, yellow, and brown to black. A very close study of the various colors of diamonds has generally proved that the grey, black, or white stones are harder than the various shades of brown. This, however, does not hold that such stones because of their hardness alone are superior to the brown stones, which are softer but not so brittle.

One should not be misled by the superficial examination of an apparently brown stone, for under the magnifying glass or microscope the body of the stone may show a quite clear crystalline structure and the color may merely be on the surface.

Quality

Although the grey and white bort and the black ballas stones are considerably harder than the brown stones, we must not overlook the fact that their hardness also makes them much more brittle. This quality is important and for inexperienced operators we would recommend the best quality brown bort stones for the following reasons:

- (1) They are sufficiently hard to withstand reasonable wear.
- (2) They are not so expensive as the black diamonds (carbons).
- (3) They are not so brittle as grey and white stones.
- (4) Diamonds may be very easily ruined by careless use, and brown diamond will stand more abuse without breaking than any other class of bort diamond.

For experienced operators in factories where particular attention is paid to the proper use of diamonds and where service

records of each stone are kept the black ballas stones for crankshaft and camshaft grinding are very often recommended for the following reasons:

(1) These stones are very hard and for severe usage on large wheels they give exceptionally good service.

(2) They are not as expensive as black (carbon) diamond.

(3) They are obtained in shapes which present a large surface to the wheel.

For general classes of precision grinding where careful use is exercised and accurate service records kept the grey or white bort stone is very often preferred for the following reasons:

(1) They are obtainable in shapes that lend themselves to secure setting.

(2) They will give a large number of dressings before being reset.

(3) They will wear considerably longer than brown bort stones.

(4) For large users, it is not necessary to carry such a big stock on hand to provide for stones being reset frequently which is necessarily the case with brown bort stones.

Shapes and Sizes

The shape of the diamond is a very important factor, an octahedron or eight-sided crystal being most desirable and economical, provided proper attention is given to the resetting of the diamond. However, the shape of the diamond should not be subordinated to the quality as there are many odd-shaped pointed stones of a knotty nature which give excellent service.

The main factors which determine the size or weight of stones used for truing purposes are:

- (1) Diameter of wheel
- (2) Thickness of wheel
- (3) Hardness or grade of wheel

The following table should be some assistance in making selection of your diamonds:

**NORTON WHEELS GRADE M AND SOFTER**

Diameter	Face	Size of Diamond
Up to 6"	1"	$\frac{3}{4}$ carat
6" to 12"	1"	1 carat
12" to 18"	1" to $1\frac{1}{2}$ "	$1\frac{1}{2}$ to $1\frac{1}{2}$ carat
18" to 24"	2" to 4"	2 to 4 carats

NORTON WHEELS GRADE N AND HARDER

Diameter	Face	Size of Diamond
Up to 12"	1"	1 carat
12" to 18"	1" to $1\frac{1}{2}$ "	$1\frac{1}{2}$ to 2 carats
18" to 24"	2" to 4"	3 to 5 carats

METHODS OF SETTING

Many different opinions are expressed with regard to the best methods to employ in setting diamonds, and too much care cannot be given this important question.

PEENING MOUNT

This method may give satisfactory results if performed by a very careful and skilled mechanic. In "peening" a diamond, however, there is great danger of damaging the stone, and for that reason this method is not strongly advised.

BRAZED-IN MOUNT

This is one of the older methods of mounting diamonds. It is only satisfactory when extreme care is used in the brazing process. Even when extreme care is exercised it is often found, when a brazed mount is opened up, that air holes are present around the back or sides of the stone which render it liable to fracture by shocks. A brazed mount really does not take a firm grip on the stone. It merely prevents it from falling out.

CAST-STEEL MOUNT

The cast-steel mount, in our opinion, overcomes many of the objections to the brazed-in mount and we feel that it is a step in the right direction. The molten metal flows around the irregular surfaces of the diamond, and on cooling down contracts and grips the stone firmly.

Some diamond manufacturers are of the

opinion that the extremely high temperature of this molten metal is liable to injure the diamonds by carbonizing the outside surface, which tends to soften it or make the stone more brittle. Small carbon spots which exist are also apt to become gaseous under the extreme heat, the expansion thus tending to weaken the diamond across the line of cleavage.

SPECIAL METAL CAST MOUNTS

As it is generally recognized that the casting of some type of molten metal around the diamond makes the best mount, it therefore only remains to determine a metal which embodies the qualities of having a very low melting point and which at the same time has a high coefficient of expansion in heating and contraction in cooling.

Several metals are employed by diamond concerns which have a lower melting point than steel and at the same time have a greater coefficient of contraction upon cooling. Another very good metal for the purpose is silver solder.

Suggestions on the Correct Use of Diamonds

The following suggestions should help to obtain more efficient as well as economical results among consumers:

- (1) Take light cuts with the diamond.
- (2) As the diamond wears, turn the nib in the holder to assure uniform wear.
- (3) When the stone wears down to the metal setting, be sure to reset the stone so as to expose a new cutting surface.
- (4) When the diamond is worn down to a small size, reset it in a holder and mark for tool room use.
- (5) Instruct operators to be careful about giving the diamond any hard knocks. The stones are very hard and for that reason rather brittle.



(6) Be careful not to jam the diamond into the wheel.

(7) Never use a diamond dry except perhaps on small wheels for internal grinding or on tool and cutter wheels.

(8) On large wheels for cylindrical or surface grinding, use a copious stream of water and direct it on the diamond at its point of contact with the wheel.

(9) Establish some card record system for keeping results of the actual service obtained from the diamond, listing such points as number of stone, original weight of stone, weight at each resetting, class of grinding for which it is employed, number of truing obtained from each setting,

total number of truing before the diamond is worn out.

Conclusion

Although this treatise has been prepared from our own actual experience in the use of diamonds and from the experience of several of the leading diamond concerns in the United States, we realize that many different opinions exist and it is doubtful whether all our thoughts and suggestions will meet with the approval of 100% of the consumers. We do feel, however, that the suggestions as outlined above will be of material benefit and service to those who have not been paying particular attention to this very important subject.

Notes from the Files of the Sales Engineering Department

Surface Grinding of Lenses

Lens blanks are shaped to the proper curvature by surfacing them on cast-iron laps with loose Alundum abrasive grain. The blanks are fastened to a cast-iron block with either "bottle wax" or asphalt pitch and brought in contact with a lap of the proper curvature on either individual hand-operated, individual automatic, or mechanically operated machines.

Generally there are three grinding operations before the final polishing—first and second roughing and finishing. There are, however, many places also where four grinding operations are made use of. Where there are only two roughing operations, 60 to 80 is used for the first, and 150 to 200 for the second. In shops where three roughing operations are

employed, 60 to 80 is used first, followed by 100 to 150 and then F to 4F.

Alundum grain has been successfully used for a long time for these grinding operations.

For the finishing operation we furnish Alundum lens finishing flour. This flour which is of somewhat recent development is proving extremely satisfactory. Number 4F Alundum flour is also sometimes furnished for this operation.

The finishing powder is applied in the form of a thick mud to the cast-iron lap which is either flat for a flat surface lens or of the proper curvature for a convex or concave surface. During the grinding process this abrasive mud is liable to become somewhat dry. Care must be



It is extremely important that a lens finishing flour be completely free from "scratchers." Scratches on the lenses due entirely to the use of coarse abrasive grains can usually be detected as harsh

Cleanliness in lens grinding is absolutely necessary for perfect work. It is better to wash off the lens after finishing by holding it under a faucet without touching the hand to the finished surface, than by wetting the hand and rubbing. The lenses should be dried by blowing on them instead of wiping them with a cloth which many times has grit of some nature on it.

After the finishing operation, the lens is ready for the final polishing with rouge.



H. W. Lehmann
is the new district manager in Cincinnati

Samuel A. Craig, Jr. former manager in Philadelphia has sailed for Japan



J. S. Anderson
is a new addition to the Ohio force



F. A. Emery,
located in London, England as assistant to foreign sales manager



W. R. Strong
transferred to Baltimore where he becomes district manager

manager. He comes from the Ohio district under A. R. Sandine to take the place formerly held by O. E. Nordstrom. Mr. Nordstrom at the present time is at the factory in Worcester where he is qualifying by further training for his future activities as a grinding machine representative. J. S. Anderson is a new addition to the Ohio force and is located in Toledo.

Leslie C. Griffin, as successor to S. A. Craig, becomes manager in Philadelphia



Down toward the land of Dixie some changes have been going on which are most important for Norton acquaintances to know. W. R. Strong who has been in Philadelphia as assistant to Samuel A. Craig, former manager of the Philadelphia district, has been transferred to Baltimore where he becomes manager in place of Leslie C. Griffin. The latter has moved north to 602 Arch Street, Philadelphia, and is Mr. Craig's successor.

Samuel A. Craig, Jr., who for years has been the efficient manager of the Philadelphia district, is now on his way to Japan where it will be his duty to represent Norton interests. This important appointment carries with it a great deal of responsibility and the business acquaintances and friends have every confidence

in Mr. Craig's success in the Orient.

Another Norton representative in the foreign field is F. A. Emery who is located in London, England, as assistant to W. LaCoste Nielson, vice-president and foreign sales manager. Mr. Emery has been engaged in his foreign duties since last fall.

Polishing Metallographic Specimens

By R. M. JOHNSON

In order to examine or photograph the microstructure of a metal its surface must be cut or ground flat, then brought to a high polish and finally treated with a chemical which, by unequal action, etches the surface, causing the less soluble constituents to appear in relief.

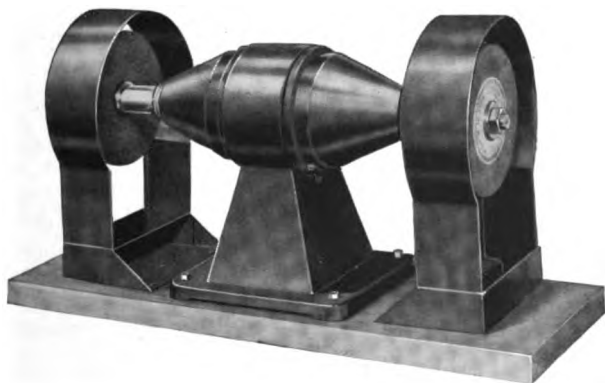
Grinding and polishing machines suitable for this work are manufactured by Sauveur & Boylston, Cambridge, Mass. and another type of machine, the Wysor, is sold by Eimer & Amend, New York, N. Y.

Sauveur & Boylston Machines

This concern markets several machines for preparing metallographic specimens,

all of which use the same kind of wheels and abrasives, the only difference being in the size of the grinding wheels.

After the sample is sawed or cut off from the material to be examined, it is ground lightly on a grain 80 grade P Alundum vitrified wheel until the saw or cut-off wheel marks are removed. The next operation can be made either a grinding or polishing one. If a grinding wheel is desired, a grain 200 grade M Alundum vitrified wheel should be used; if abrasive is used it should be No. 2F Alundum flour. This is made into a thin paste and used on a composition disc covered with duck.



Sauveur & Boylston Grinding and Polishing Machine

After this operation the sample should be carefully washed to remove all traces of abrasive. The sample is then polished on another composition disc covered with the best grade of black broadcloth on which is placed a thin emulsion of tripoli powder. The sample should then be thoroughly washed again and the final polish put on with a thin emulsion of levigated alumina on a black broadcloth-covered disc. Occasionally, the sample is so soft that it is necessary to finally polish with rouge in order to completely eliminate the scratches.

In each case when the sample is changed from one finishing disc to the next finer, it should be rotated 90 degrees so that the marks made by the abrasive will be removed completely by the next finer material.

Where the initial sample or metal surface is fairly smooth, it has been found

unnecessary to use the grain 80 grade P Alundum vitrified wheel, the first and last grinding being done with a 200 grade M Alundum wheel.

Wysor Machine

This machine is so arranged that the grinding wheels run on a horizontal spindle, but connected to this horizontal shaft is a friction disc by means of which a vertical spindle, having a lapping plate at the end of the shaft, is driven.

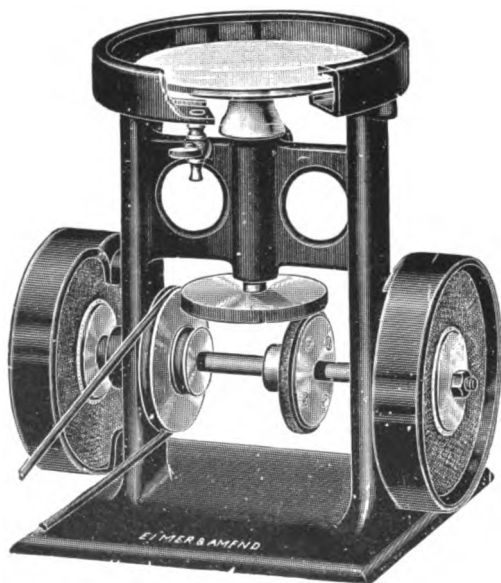
The wheel used for the first operation is 6 x $\frac{3}{4}$ x $\frac{3}{8}$ " grain 46 grade 4 Alundum elastic. The second operation is taken care of with a finer wheel 6 x $\frac{3}{8}$ x $\frac{3}{8}$ " grain F grade N or O Crystolon vitrified. Still a third wheel 6 x $\frac{3}{8}$ x $\frac{3}{8}$ " grain XF grade M or N Crystolon is used for producing a sort of semi-polish preparatory to the use of abrasive powders.

After the samples have been ground with the three wheels, fine abrasive flours are used for producing the very finely polished surface which is required. Our 65C and 65F Alundum powders are used successfully for the first polishing operation. The final work in most cases is done with levigated alumina. Occasionally, however, if a soft metal which is readily scratched is being polished, it may be necessary to use tripoli or rouge after the levigated alumina.

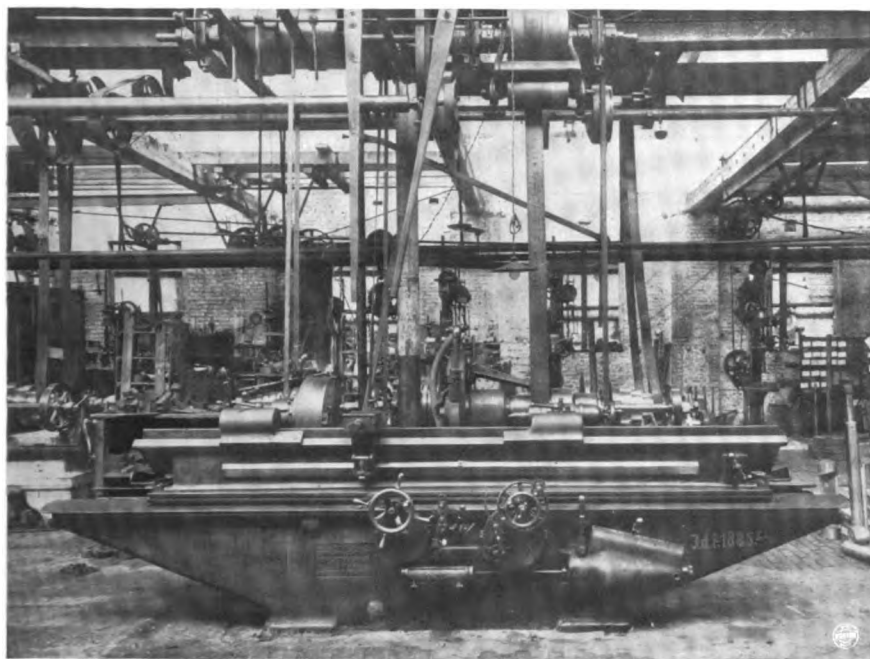
When using the polishing powders they should be mixed with water to the consistency of flowing paste. Small glass bulbs are furnished with the Wysor machine for holding these pastes.

The illustrations give an idea of the type of machines which are used for this kind of work. Further information along these lines will be gladly furnished by the Norton Sales Promotion Department.

(Acknowledgment is made by the editors to Sauteur & Boylston, Cambridge, Mass., and Eimer and Amend, New York, N. Y., for their courtesy in lending the illustrations for this article.)



Wysor Polishing Machine



Norton Grinding Machine. purchased by the Bollinckx plant in Brussels in 1902

Norton Grinding Machine Comes Through War

The above photograph is of an 18 x 96" Norton grinding machine, serial No. 17.

This machine was built in 1902 and has been operating at the Bollinckx plant in Brussels since that date. When war was declared in August 1914 it was taken over by the Germans and operated at the same factory until June 1917. At this time it was shipped to Germany where it was apparently used until June 1919, when it was returned to Brussels.

Mr. Bollinckx spent about \$800 (pre-war rate of exchange) in putting the machine in shape, and it is now operating very successfully. This concern manufactures gas and steam engines and their one lathe is used entirely in roughing the work to be finished on this grinding

machine. Mr. Bollinckx personally was one of the pioneer subscribers to the American technical magazines in Belgium.

In the photograph may be noted a number at the right hand end of the machine. It was placed there by the German authorities upon shipping the machine to Germany. The Germans worked out a very extensive system for this work, sending to each country, France and Belgium, a commission who visited all the shops and looked over the machines which could be used in their own country. The machines were then given a number which corresponded to the destination and factory in which they were to be placed. This commission consisted of men who understood the uses of these machines thoroughly.



Abstracts from Current Articles Pertaining to Grinding

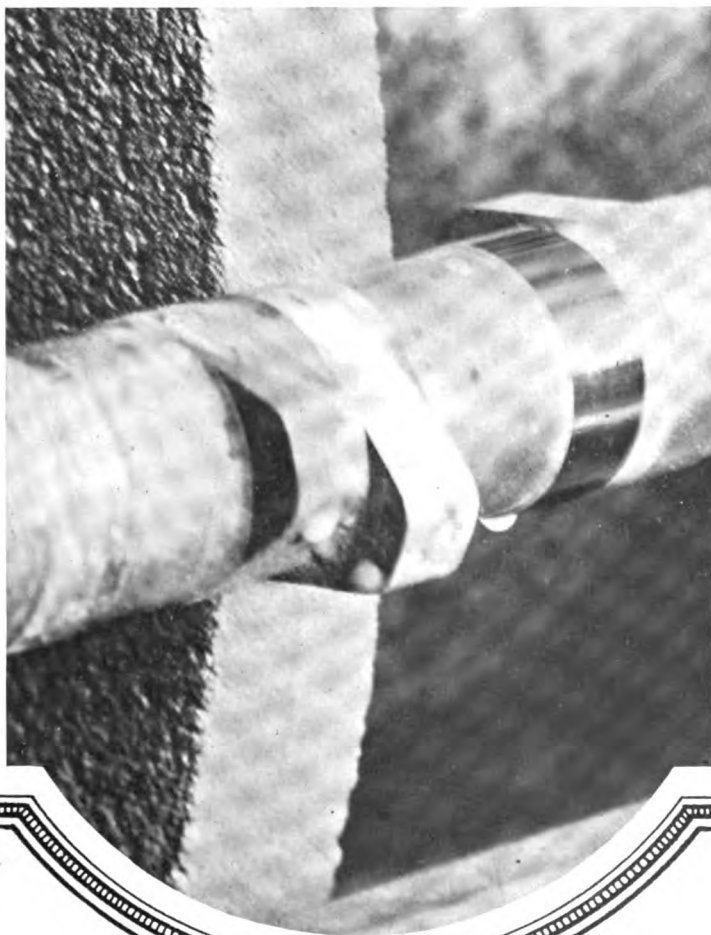
Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

- New 6-Inch by 20-Inch Plain Grinder. American Machinist, European edition, December 13, 1919, page 110E. Description of the smallest of plain grinding machines being manufactured by Wadkins, Mills & Co., Ltd., Nottingham.
- Roll Grinding. Machine Tool Review, September-November 1919, page 168.
- Grinding Twist Drills. Machine Tool Review, September-November 1919, page 173. The fixture illustrated is a means for supporting the lip end of a twist drill in a grinding machine so that the shank of the drill can be ground either straight or taper.
- Problems in Designing an Engine Camshaft. Automotive Industries, December 4, 1919, page 1116. The grinding operation is discussed in the last part of this article.
- The Gordon Camshaft Lathe. American Machinist, December 25, 1919, page 1085. The last paragraph of this article is devoted to a description of a special machine built for grinding the controlling cams to form.
- A Surface Grinding Machine. American Machinist, December 25, 1919, page 1111. The writer describes a spring end thrust which he devised to overcome the trouble experienced in grinding with the side of a wheel on a surface grinding machine.
- "Mephisto" Bits; How They Are Made. American Machinist, January 1, 1920, page 11. An account of the various processes of manufacture as performed at the W. A. Ives Mfg. Co., Wallingford, Conn. One of the grinding operations is done not with an abrasive wheel but with a steel wheel running at a very high peripheral speed.
- Necessity for Keeping Grinding Wheels in Perfect Balance. American Machinist, January 1, 1920, page 45.
- Reid No. 2 Surface Grinding Machine. American Machinist, January 1, 1920, page 51. A description of an improved model manufactured by Reid Brothers Co., Inc., Beverly, Mass.
- Fitchburg 8 x 36-Inch Plain Cylindrical Grinding Machine. American Machinist, January 1, 1920, page 52. Description of a line of plain cylindrical grinding machines placed on the market by the Fitchburg Grinding Machine Co., Fitchburg, Mass.
- Semi-Automatic Grinder. Canadian Machinery, December 25 1919, page 624. The Woods Engineering Co., Alliance, Ohio, have recently placed on the market a new machine known as a semi-automatic wide wheel grinder.
- Miller Radius and Angle Grinding Wheel Dresser. American Machinist, January 8, 1920, page 104. The S. L. & M. Sales Co., 408 Moffat Building, Detroit, Mich., has placed on the market a tool for dressing abrasive wheels with radius or angular faces.
- Grinding a Rear-Axle Housing. American Machinist, January 8, 1920, page 92.
- Making Special Snap Gages. American Machinist, January 8, 1920, page 83. This article shows fixtures and describes methods of using them for grinding large and small snap gages.
- How To Buy Abrasive Wheels. Purchasing Agent, January 1920, page 43.
- Testing Abrasive Wheels for Efficiency. American Machinist, January 15, 1920, page 139. An account of the operation of this machine devised for testing the efficiency of abrasive wheels was given in an issue of the Scientific American Supplement last June.
- Multi-Graduated Precision Grinding Attachment. American Machinist, January 15, 1920, page 160. This equipment is made by the Precision and Thread-Grinder Mfg. Co., 1932 Arch Street, Philadelphia, Pa.
- Experience with the Band Saw Grinder. Wood-worker, January 1920, page 44.
- Proper Way to Grind Drill Bits. Wood-worker, January 1920, page 52. The writer states some points to be kept in mind when grinding drill bits free-hand.

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Cam Grinding and the Grinding of Irregular Shapes

By H. B. LINDSAY

The camshafts of American automobile engines have been designed by men who rely upon Norton grinding equipment to reproduce in metal with great exactness and economy the contours required for quiet, efficient operation of the motor. The tendency in cam design is toward small clearances and low valve seating velocities, which means greater attention to "quieting curves" and a still more exacting demand of the cam grinding machine. These requirements have been anticipated, with the result that Norton cam grinding equipment will continue to be standard in the largest automobile plants in this country and abroad. In addition to the usual type of loose cams and integral camshafts, there are many eccentric shapes combining tangential and curved outlines, which are being produced in quantities on cam grinding attachments.

The principles of the operation are shown in figure 1 where the master cam, follower roll, grinding wheel, and cam are illustrated diagrammatically. "W" represents a weight or spring arranged to keep the master cam in contact with the roll. The distance "B" between wheel

center and roll center is variable to allow the wheel to be fed into the work.

The Number 2 loose cam grinding attachment is shown in figures 2 and 3. Motion is transmitted to the attachment by the headstock through the crank at "A." The hardened master cam which produces the desired shape on the cam blank is mounted at "B" and the attachment oscillates on the trunnions "C." The cam blank is mounted on the centers and is supported by the overhanging arm "D." Means are provided for lifting the work away from the grinding wheel by lever "E." The cam is driven by dog "F," proper speeds being obtained through the regular speed change mechanism in the headstock of the grinding machine. The several attachments have capacities in swing of $1\frac{5}{8}$ ", $2\frac{7}{8}$ ", 5", and 7" and in lift of $\frac{3}{4}$ ", $1\frac{3}{8}$ ", $1\frac{1}{2}$ ", and 3" (see figure 4), and are adapted for use on the 10", 14", and larger Norton cylindrical grinding machines.

The integral cam grinding attachment, which takes its name from the style of cams it is designed to grind, is illustrated in figures 5 and 6. Two types and two sizes are manufactured, the two types

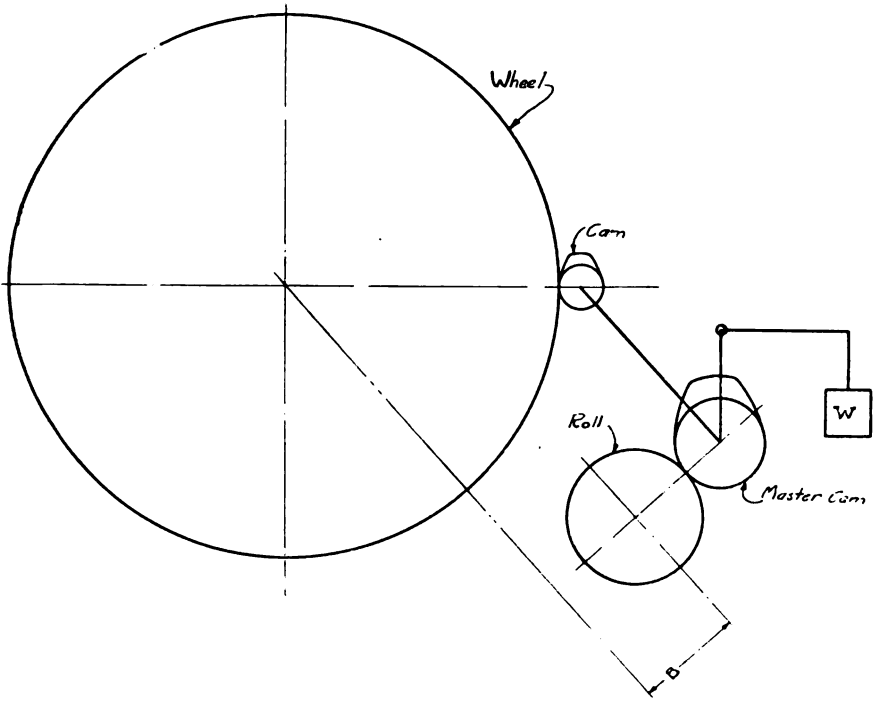


Figure 1

differing only in the method of driving, one getting its power through the headstock of the machine, whereas the other is belted direct from overhead. Both have their advantages. Where a variety of work is to be done the first is recommended, as it is possible by simply removing the attachment from the table of the machine to handle any form of cylindrical grinding. In the latter case the head and footstock of the machine are omitted and the attachment occupies the entire table surface (making possible a shorter machine), and is confined to the grinding of camshafts where large quantities are required. In size the attachments are capable of swinging 2" and 2 $\frac{3}{8}$ ", with a lift

of $\frac{1}{8}$ " and $\frac{3}{4}$ " (see figure 4), and will handle camshafts up to 58" over-all length, having from one to fourteen cams to be ground. They are adapted for use on 10", 14", and larger machines.

Figure 5 shows the attachment on the machine in operating position; figure 6 is a nearer view of the rear of the headstock end of the attachment. "A" is the driving arm; "B" the master cams on the master cam spindle; "C" the roll which is quickly located before the proper cam by sliding along shaft "D." "E" is the encased spring which holds the master cam snugly against the roll. "F" shows the driving dog in position; "G" the steady-rests; and "H" the footstock,

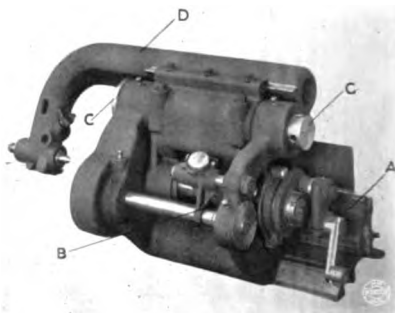


Figure 3. Rear View

which is movable to allow for different lengths of camshafts, which are carried on the centers of the attachment.

from .012" to .020"; Norton grain 6630, grade K, and grain 3836, grade J are suitable wheels for finishing.

In general, it may be said that production is largely in the hands of the operators. Two men, working at machines side by side in a large automobile plant, roughing (semi-finishing), and finishing eight-cylinder camshafts, have the same equipment and wheels; one man turns out

Smooth, efficient engine performance is largely dependent upon camshaft design, but unless the contours laid out by the designer are reproduced faithfully in the metal his purpose will have been defeated.

Integral camshafts are roughed from the black forging, removing from 0.030" to 0.125" stock; the wheel recommended for this operation, for use with Norton equipment, is Grain 24 Combination, Grade O, Alundum Vitrified. If harder grades are used for roughing, the roll may not follow the master cams accurately and, although the production at this stage will show an increase over that of the softer wheel, the finishing operation is prolonged by the necessity of correcting the errors of contour introduced in the effort to rough at a high rate.

After hardening, the finish grinding is often done in two steps, semi-finishing and finishing, without removing the shaft from the centers. Stock removed varies

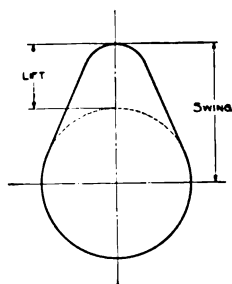


Figure 4

six and the other nine shafts per hour. At an automobile plant in Detroit, eight-cam shafts are semi-finished and finished by one man at the rate of fourteen per hour. This operator has been grinding cams for two years. Softening, checking, and chattermarks are defects which

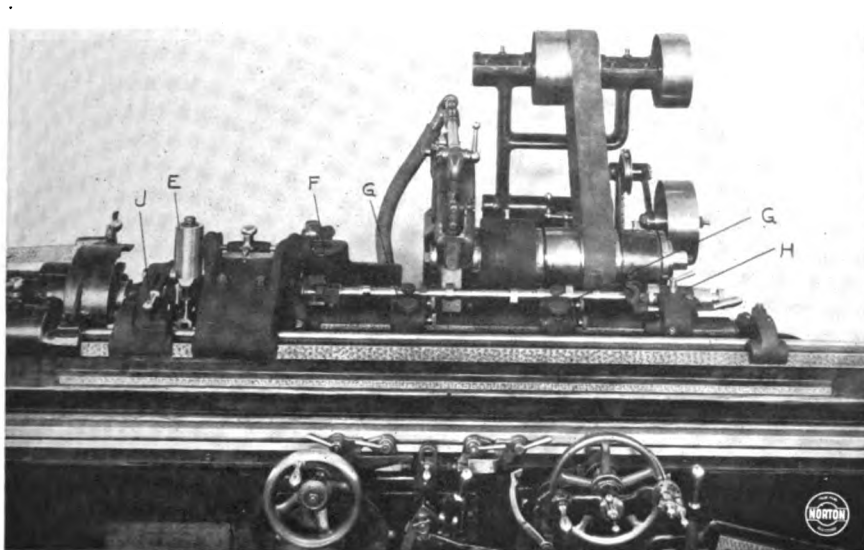


Figure 5. Integral Cam Grinding Attachment

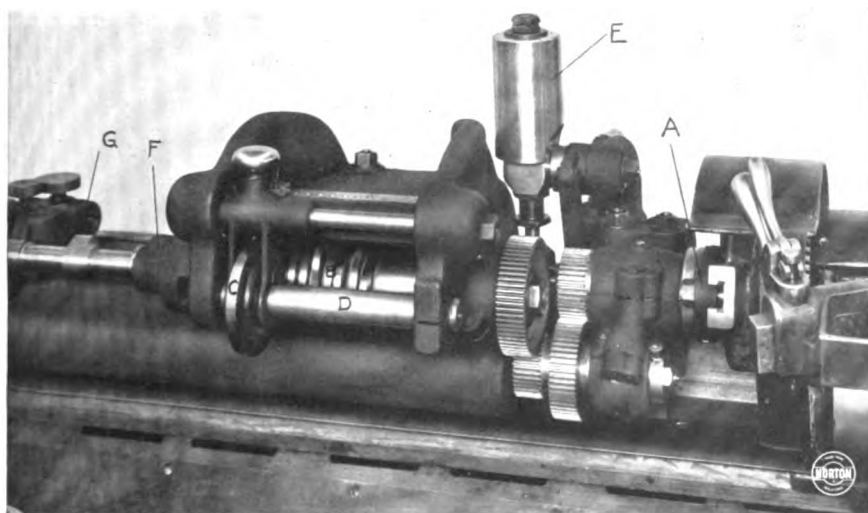


Figure 6. Rear View—Showing Master Cams and Follower Roll

[APRIL, 1920]

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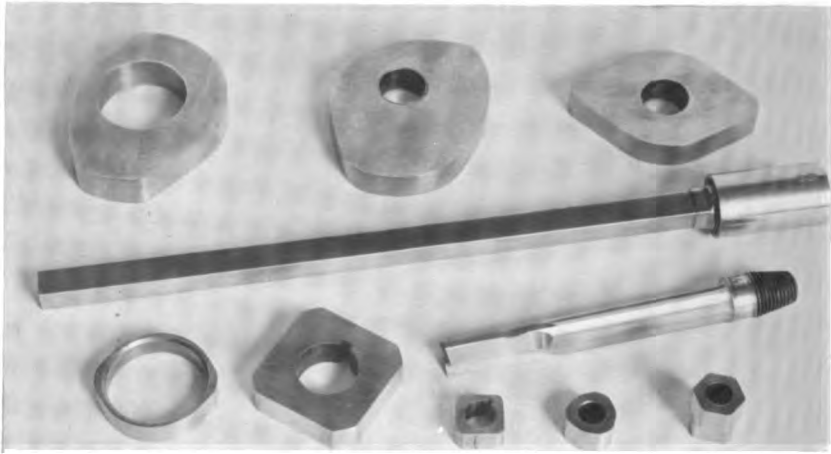


Figure 7. Irregular Shapes Ground on Norton Cam Grinding Attachments

may arise from the use of wheels too hard for the work or from an attempt to crowd production above a point consistent with the requirements of finish and accuracy.

Other Uses for Cam Grinding Equipment

Cam grinding equipment may be used for quantity production of irregular shapes such as those illustrated in figure 7. The manner of grinding automatic pistol barrels is shown in figure 8. As the possibilities of this form of grinding are appreciated, many eccentric and non-cylindrical sections which are now laboriously milled will be ground with the same facility with which cylindrical and plain surfaces are already so universally produced by grinding machinery.

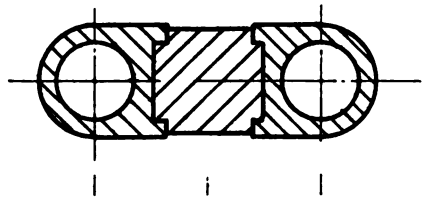


Figure 8

In approaching a new grinding problem of this character the speed of work rotation, abrasive grain size, and grade of wheel must be chosen with even more than usual care because there are likely to be variations from plain surface to small radius contacts in each revolution of the piece. Such operations should be undertaken only with the advice of competent grinding engineers. The Grinding Machine Division of Norton Company offers its services in this connection

Grinding Ball Bearings

By A. F. MELLEN AND W. T. MONTAGUE

The last few years have seen a very rapid expansion in the fields of usefulness for the modern ball bearing. With the greatly increased demand for automobiles, both passenger cars and trucks, tractors, and machine tools, has come a correspondingly greater demand for ball bearings. The grinding wheel has played a very important part in the development of the manufacture of ball bearings. Without grinding wheels, the refinement and accuracy of the present bearings, and consequently their success, would be impossible.

The material employed for ball bearings is usually a good grade of chrome steel with about 100 points carbon and from 100 to 150 points chromium. The average scleroscope reading of such steel after hardening would be around 90. The manufacturer of the ball bearing must be very careful to see that he secures—first, accuracy of race contour; and second, raceways uninjured by grinding. These demands call for well designed and well kept up grinding machines; and wheels which are free and cool cutting, of reasonable life, leaving, however, a good finish.

Without considering the question of grinding the balls (which is a separate manufacturing problem entirely), the grinding of the races and separators calls for the use of a number of different types of grinding machines and wheels. The purpose of this article is to mention some of the machines used on the various operations, together with a brief survey of some of the common grains and grades of wheels employed and difficulties to be avoided in grinding.

The choice of grinding wheel naturally varies somewhat with the type and condition of the grinding machine, the requirements as to finish, the class of steel used, and its heat treatment, the capabilities of the grinding machine operators and their familiarity with and understanding of grinding wheels.

Very briefly, let it be said that the bearings are rough turned from tube stock. The sides of the rings are surfaced to an oversize limit on vertical surface grinding machines, such as Blanchard or Pratt & Whitney. The rings are then hardened, after which they are finish ground to size on the sides on the same type of vertical surface grinding machines.

Some of the more important grinding operations are listed below:

Surface Grinding Sides of Outer and Inner Races and Separators

Blanchard Vertical Surface Grinder:

16 x 5", 1¼" rim, 3824-H to I silicate process.

18 x 5", 1½" rim, 3824-G to H silicate process.

Pratt & Whitney Vertical Surface Grinder:

14 x 4 x 10³/₈", 3830-H to I silicate process.

Walker Single Stroke Surface Grinder:

8 x 3 x 4", 3824-J to K vitrified process.

Internal Grinding Bore or Hole of Inner Race

Heald, Bryant or Grinding Machines of Special Design:



Grinding the Groove in an External Race

$\frac{3}{4} \times \frac{1}{2} \times \frac{1}{4}$ ", 3846 or 3850 or 3860-K vitrified process, to

$4 \times \frac{1}{2} \times \frac{3}{8}$ ", 6650 or 6660 or 6670-K vitrified process.

The smaller the hole to be ground, in general the finer the wheel should be.

Cylindrical Grinding Outer Races

Norton Machine $14 \times 2 \times 5$ ", 6636-L roughing.

Landis Machine $14 \times 1 \times 5$ ", 3846-L, 3850-K, 3824 Combination L.

Cincinnati Machine $14 \times 1\frac{1}{2} \times 5$ ", 6636-L roughing.

Special Machine $12 \times 1\frac{1}{2} \times 2$ ", 6636-J roughing, 6636-Combination K finishing.

Cylindrical Grinding Grooves of Inner Races

Special Machines of Van Norman Type: $10 \times \frac{1}{4}$ " to $10 \times \frac{3}{4}$ ", 6670 to 6690-K vitrified.

$12 \times \frac{1}{2}$ " to $12 \times \frac{3}{4}$ ", 3860-K to M vitrified.

$14 \times \frac{1}{2}$ " to $14 \times \frac{3}{4}$ ", 3880-M vitrified.

Internal Grinding Grooves of Outer Race

Special Machines of Van Norman Type: $1\frac{1}{2}$ " to 5" diameter, and $\frac{1}{8}$ " to $\frac{3}{4}$ " thick—3860-K to L vitrified, 6670-K vitri-

fied, 6680-K vitrified, 6660-3 elastic, 6670- $1\frac{1}{2}$ to 2 elastic, 66100-3 elastic.

Internal Grinding or Counterboring Outer Rings

Internal Grinders, Special Design:

$1\frac{1}{2} \times \frac{1}{4}$ " to $3 \times \frac{1}{2}$ ", 3860-K vitrified, 6660-K vitrified, 6670-K vitrified.

There are many important points to be taken into consideration in grinding the races. Roughness or coarse-grained finish on the surface of either the balls or raceways will result in the rapid destruction of the bearing. Therefore, the finish obtained in grinding must be carefully watched and likewise later the finish obtained in the final polishing.

Inaccuracy in the surface of either balls or raceways would cause an uneven distribution of load so that certain sections of the bearing would be subjected to excessive stresses, which might be sufficient to start wear. For this reason, great care has to be used in grinding to hold all dimensions within very narrow limits and the grinding machines must be kept



Showing Contact Between Ball and Raceway



[9]



may be caused by a wheel of too fine grain, too hard grade, or both; by forcing the wheel beyond its cutting capacity; by using a wheel after it has become glazed; or by grinding dry or with an insufficient supply of lubricant.

So called "skin softening" is also something that might be caused by improper grinding wheels or methods of grinding, insufficient or erratic supply of lubricant. Some manufacturers, in an effort to get a bright polished finish direct from the grinding wheel, have tried to use wheels that are entirely too hard—even rubber bonded wheels of hard grade. This is something to be avoided, unless the grinding is done very slowly and the work flooded with a large volume of lubricant applied at low velocity and directly on the arc of contact between the wheel and the work.

Most raceways are ground with streams of lubricant of too small size and improperly directed. Workmen are careless about this and it is difficult to get them to follow directions. But any one who can insist upon the proper use of lubricant will be well repaid in the improved quality of product. The life of a bearing is usually the life of its raceways. Therefore, nothing should be done which might tend to reduce this life.

Strains set up in hardening may be contributory of grinding cracks. For this reason, a number of manufacturers allow their bearings to season some time between hardening and grinding.

The polishing of the raceways is accomplished with fine abrasive cloth or soft

leather pads dipped in fine abrasive and oil and held on the end of a formed hardwood stick. Application to the bearing is by hand. Although possibly not more than .00025" may be removed by this operation, this hand work tends to destroy the exactness of race contour, which has been built up so carefully in preceding manufacturing steps.

There is undoubtedly room for improvement on this polishing operation, but practical methods which remove the difficulties of hand work are not easy to find. It is difficult to arrive at a given degree of polish or finish by any other than hand means. It is all the more reason why the grinding of the raceways should be done with a wheel that will give the best finish consistent with rapid production and without injuring the steel. We would suggest leaving as little material for the polishers as possible.

Norton Company's Alundum abrasive, designated by the term No. 66 Alundum, produces a very good finish, is cool cutting, and does not have to be dressed as often as wheels composed of other abrasives. The number of grindings with satisfactory finish per dressing is largely a measure of the efficiency of any wheel on ball raceway and hole grinding. No. 66 Alundum wheels of correct grain and grade seem to have this quality to a marked degree.

Any one desiring to test wheels of this abrasive may do so by consulting with the Norton district representatives or the Sales Engineering Department at Worcester.



Notes from the Files of the Sales Engineering Department

Hard vs. Soft Wheels for Snagging

A few examples showing a comparison of hard and soft wheels for snagging steel castings and billets are given below:

Open Hearth Steel Castings

Wheel used—18 x 2 x 2 $\frac{3}{4}$ " , $\frac{3}{4}$ " taper both sides

Labor—piece work

Overhead—\$1 an hour

Grain and Grade

6610-U 0115 Alundum Vitrified

Av. Wheel Life, Hrs.	Lbs. of Castings Ground per Hr.	Total Cost per Ton
47.5	874	\$4.16

Grain and Grade

6610-W 0115 Alundum Vitrified

Av. Wheel Life, Hrs.	Lbs. of Castings Ground per Hr.	Total Cost per Ton
100.0	700	\$4.91

The interesting part of this test is the fact that although the wheel life was increased more than 100 per cent using the harder wheel, the total cost per ton (including overhead) was increased nearly 20 per cent. This is due to the slower cutting of the harder wheel.

High Speed Steel Billets

Wheel used—14 x 1 $\frac{1}{2}$ x 1 $\frac{1}{2}$ "

Labor—\$.43 per hour

Overhead—\$15 a day

Grain and Grade

26-U Alundum Vitrified

Av. Wheel Life, Hrs.	Steel Ground Off per Hr., Lbs.	Total Cost per Lb. of Steel Ground Off
60	1.32	\$.85

[APRIL, 1920]

Grain and Grade

20-R Alundum Vitrified

Av. Wheel Life, Hrs.	Steel Ground Off per Hr., Lbs.	Total Cost per Lb. of Steel Ground Off
39	2.21	\$.61

The life of a grain 20 grade R wheel was only 65 per cent of that of a 20 grade U wheel. The total grinding cost, however, was reduced about 30 per cent by using the 20 grade R wheel, due to increased hourly production.

High Speed Steel Billets

Wheel used—14 x 2 x 1 $\frac{1}{4}$ "

Labor—piece rate

Overhead—\$.90 an hour

Grain and Grade

20-W Alundum Vitrified

Av. Wheel Life, Hrs.	Steel Ground Off per Hr., Lbs.	Total Cost per Lb. of Steel Ground Off
61.2	2.4	\$.57

Grain and Grade

20-R Alundum Vitrified

Av. Wheel Life, Hrs.	Steel Ground Off per Hr., Lbs.	Total Cost per Lb. of Steel Ground Off
22.0	4.1	\$.43

These figures show that by reducing the wheel life to practically one-third of that obtained with the 20 grade W wheels, the actual grinding cost was reduced from 57 cents to 43 cents per pound of steel ground off

[11]



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

Improved Spindle Construction for Badger Grinding Machines. American Machinist, January 29, 1920, page 259. An account of the ball-bearing spindle mounting which the Badger Tool Co., Beloit, Wis., has adapted for its grinding machines.

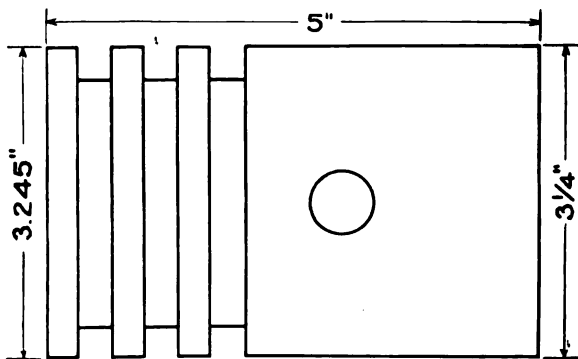
High-Speed "Red-E" Lathe and Grinder Center. Machinery, February, 1920, page 582. The Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., has developed the "Red-E" high-speed

center for use on lathes and grinding machines.

Finishing Liberty Motor Connecting-Rods. American Machinist, February 26, 1920, page 457. Five grinding operations are described and interesting data given concerning the kind of machine and wheel used, the method of performing the work, the wheel speed, and the rate of production.

Removing Grinding Wheels. American Machinist, European edition, February 14, 1920, page 182E.

Six Hundred and Fifty in Ten Hours



Piston— $3\frac{1}{4}$ " diameter by 5" long
Material—cast iron
Limit—plus or minus .001
Stock removed—.015" to .022"
Machine—14 x 50"

Wheel—Crysolon 24 x 2 x 5"
36-J
Production—650 in 10 hours, 130
from one truing of wheel, 19,280
in the life of the wheel

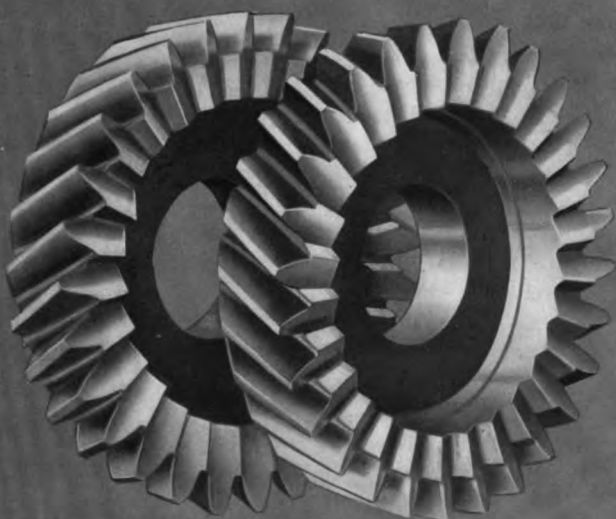
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GRITS and GRINDS

MAY

1920



How Helical Gear Shaper Cutters Are Ground
Page 3 of this issue



GRITS and GRINDS

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Sharpening Gear Shaper Cutters

(Reprinted with illustrations through the courtesy of the Fellows Gear Shaper Co., Springfield, Vermont, from their Operator's Handbook)

The importance of keeping the Gear Shaper cutter sharp cannot be too strongly emphasized. A dull Gear Shaper cutter cannot be expected to produce a smooth finish any more than can any other dull cutter. Furthermore, a dull cutter consumes much more power, and does not remove the metal as fast as a sharp cutter. It is such a simple proposition to sharpen the Gear Shaper cutter that there is no plausible excuse for using a dull one. A properly adjusted Gear Shaper and a sharp Gear Shaper cutter is the one sure and easy way of securing accurately cut gears.

Sharpening the Spur Gear Shaper Cutter

The sharpening of the Gear Shaper cutter, see figure 1, is a simple proposi-

tion—a plain job of face grinding. No indexing is necessary on the spur cutter. There are two common methods of sharpening the Gear Shaper cutter; one is to use a universal grinding machine as shown in figure 2, holding the cutter by means of an expansion pin chuck and centering it to run true, and then setting the head off to an angle of 5 degrees. The sharpening of the cutter is then a simple matter of traversing the cutter past the face of the grinding wheel.

Another method, and a preferable one where a rotary surface grinder is to be had, is shown in figure 3. In this case, the cutter is centered to run dead true on the magnetic chuck by means of a close-fitting brass plug, and care should be taken to see that the top face is ground true

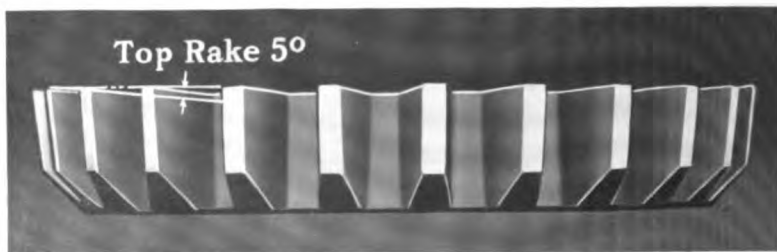


Figure 1—Spur Gear Shaper Cutter

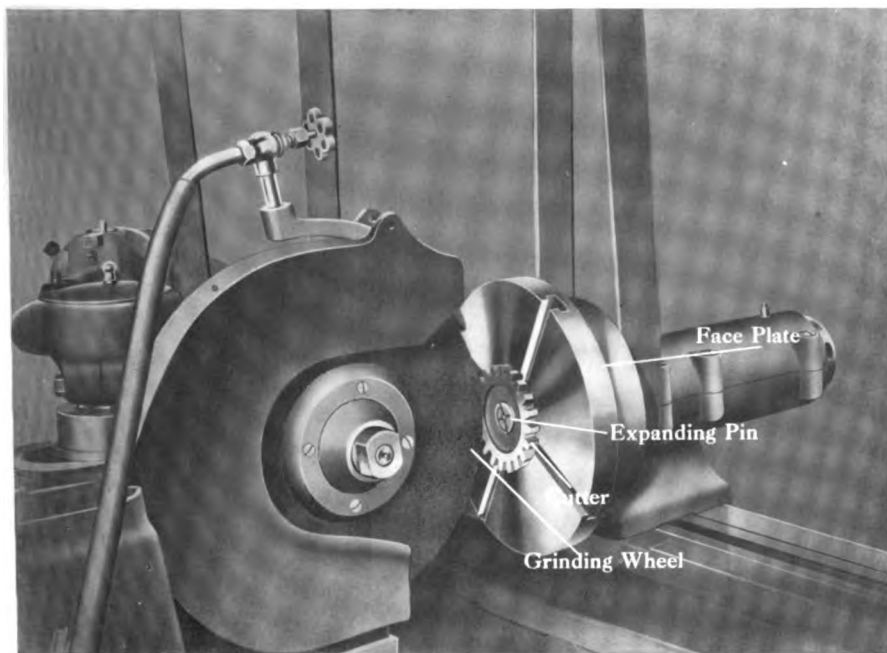


Figure 2—Sharpening Spur Cutter on Universal Grinding Machine

with the back face. The work table is set off from the vertical position to an angle of 5 degrees, and the cutter sharpened by traversing the grinding wheel back and forth across the face of the cutter.

Sharpening the Helical Gear Shaper Cutter

The Helical Gear Shaper cutter, see figure 4, requires a little more careful attention in sharpening than does the spur cutter. It is sharpened in a manner somewhat similar to that of a milling cutter, but is a much simpler proposition. As is shown in figure 6, two angular settings are required to sharpen the Helical Gear Shaper cutter. One angular position is governed by and is the same as the helix angle of the cutter tooth. The other is the top rake, and is set at 5 degrees, the same

as the spur cutter. The preferable way to sharpen the Helical Gear Shaper cutter is to use a tool and cutter grinder, as shown in figure 5, and on this, use the special attachment that is sold for this work by the Fellows Gear Shaper Company.

Reference to figure 6 will show that the cutter is held on an extended arm of the attachment that can be swivelled to the desired angle corresponding with the helix angle of the cutter teeth—making the face of the tooth at right angles to the helix angle. The arm, in addition, is located permanently at an angle of 5 degrees with the top face of the cutter-grinder table. The indexing mechanism consists simply of a spring stop, the front end of which is made to fit in the

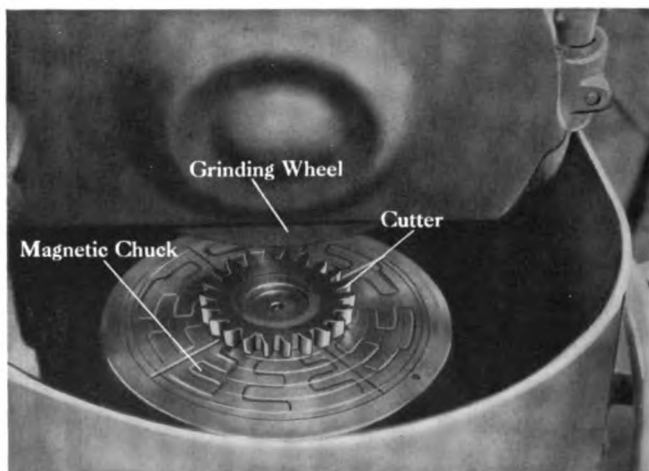


Figure 3—Sharpening Spur Gear Shaper Cutter on a Rotary Surface Grinding Machine

space between the teeth. Before setting the spring stop, however, the cutter should be centered by means of the centering gage (shown detached from the fixture, in figure 5), provided for that purpose; and the tooth used for centering the cutter is the first tooth on which the grinding is done. The index plunger swivel plate (see figure 6) is then adjusted so that the indexing plunger stop will locate properly in the space between the cutter teeth. The sharpening is done by traversing the cutter back and forth beneath the grinding wheel. The wheel should be kept with a true face, and for this purpose, a diamond truing device, which is held on the table of the grinding machine, is used. Light cuts should be taken in order to avoid burning the cutter, as it is impossible to use a coolant.

Grade and Grain of Grinding Wheel for Sharpening Spur Gear Shaper Cutter

Spur Gear Shaper cutters which are made from high-speed steel require considerable care in grinding in order to

prevent checking of the cutter face, caused by unequal heating and cooling. For this reason, the spur cutter should always be ground "wet" and a copious supply of cutting compound or water furnished. On the universal grinding machine, as shown in figure 2, this is a little more difficult of accomplishment than on the vertical rotary surface grinder, see figure 3.

The grinding wheel to use is governed by several conditions, viz., depth of cut, speed of wheel, and cutting compound used. For our own work, we find that an alundum wheel, grain 46, grade J, operated at 4,500 surface feet per minute, gives the best results. This wheel is 10 inches in diameter, $\frac{3}{4}$ -inch face. The cutter is rotated at a speed of 120 feet per min-

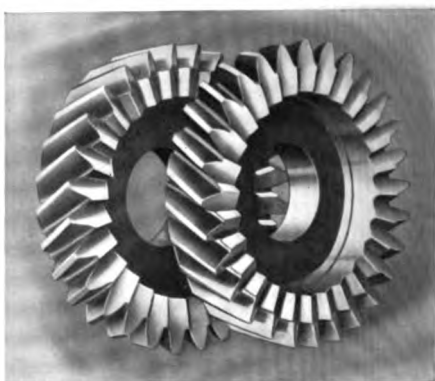


Figure 4—Right and Left-hand Helical Gear Shaper Cutters



Figure 5—Sharpening Helical Gear Shaper Cutter on a Tool Grinding Machine Equipped with Special Helical Cutter Sharpening Fixture

ute. The depth of cut recommended should not exceed 0.0015 inch per traverse of the wheel over the work, and the traverse feed should not exceed 20 inches per minute. The last three or four traverses should be made without any up feed to the work table, so as to get a smooth finish. The cutter while being ground should be completely submerged in a cutting compound or water.

[MAY, 1920]

Grade and Grain of Grinding Wheel for "Dry" Sharpening

In sharpening the Helical Gear Shaper cutter more trouble would be experienced in furnishing a copious supply of cooling compound, and for this reason, the helical cutter is always ground "dry." The grinding wheel which has been found to give the best results is an alundum wheel, grain 46, grade J, 4 inches in diameter,

[5]

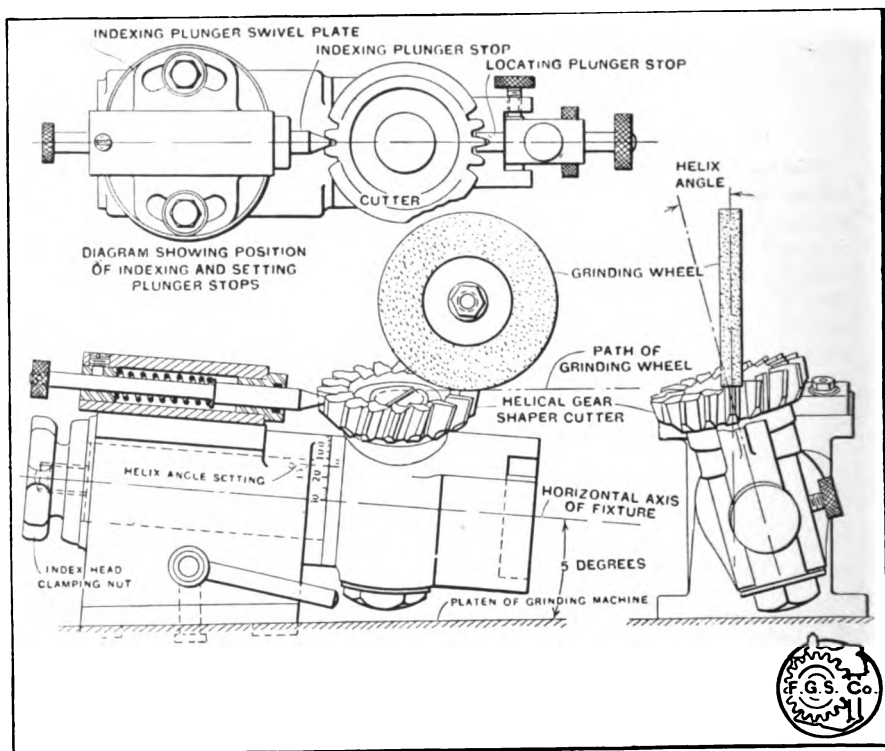


Figure 6—Diagram Illustrating Angles at which the Helical Cutter is Held when Sharpening

$\frac{1}{2}$ -inch face. This is operated at a surface speed of 4,300 feet per minute. The traversing of the cutter under the wheel is done by hand, and the up feed per traverse should not exceed 0.001 inch per traverse. It is advisable to take a large number of light cuts rather than fewer heavy cuts, for the reason that if the cut is too heavy the face of the cutter teeth will become checked.

The cutter should be kept as cool as possible and it is preferable to cut slowly than check the face of the cutter. For finishing, the cutter is indexed around twice without any feed, so as to get a

fine smooth finish on the cutter-teeth faces.

Cooling Compounds for Cutter Sharpening

The cooling compound for wet grinding is a question that there is considerable difference of opinion on. Water is about as good a coolant as can be obtained, but it has the disadvantage of rusting the moving members of the machine. A cooling compound which has been used with good results is soda water. This comprises one pint of sal soda to 10 quarts of water. The solution is mixed cold and applied in the usual manner.

Grinding Wheel Hardness Versus Metal Hardness

BY H. W. WAGNER

Hardness of metals and hardness (denoting grade) of grinding wheels have separate meanings.

A metal is said to be hard when it resists penetration by a point or a tool. The same term as applied to grinding wheels refers to the strength of the bond which holds the abrasive grains together, without reference to the hardness of the abrasive.

Metals and Other Engineering Materials

Several methods are practiced to determine the hardness of materials. One cannot accurately describe this property of a lathe tool, for instance, unless he specifies the means by which the hardness was measured. Six general methods are listed here.

1. *Scratching*—When a point of one material will scratch the surface of another, and when the converse is not true, the first material is said to be the harder. The Mohs scale has 10 minerals as standards. Diamond, the hardest, is 10; sapphire is 9, while the gap between the two is very wide. A jack knife blade comes between 6 and 7 on this scale. Results of this test cannot be translated into figures sufficiently accurate to make it valuable for the metal worker.

2. *Filing*—The experienced tool maker can tell the relative hardness of different pieces of steel by trying a hand file on them.

3. *Drilling*—The cutting hardness of soft metals can be determined by the Bauer method. The hardness numeral assigned to the metal tested depends upon the depth of hole drilled for a certain

number of turns of the drill fed in by a constant pressure.

4. *Indentation by a steel punch*—The Martel hardness numeral depends upon the weight of the pointed punch, upon the height it falls to the metal tested, and upon the volume of the indentation it makes. This is a French method.

5. *Scleroscope*—A light hammer with a diamond set in its lower end is dropped from a standard height upon the material under test. The scale height to which the hammer rebounds inside its glass tube is then noted.

6. *Brinell*—A hardened steel ball is forced, under a heavy constant pressure, against the surface of the test specimen. The hardness numeral is then figured from the diameter of the impression left by the ball, or from the depth of penetration while the pressure is on. One



The Shore Scleroscope is Used for
Measuring Hardness



The Brinell Machine which is Employed in the Brinell Method

modification of the Brinell method is to substitute a pointed tool for the round ball. Both the Shore scleroscope and the Brinell machine would place certain specimens of iron and steel in the same relative order of hardness; but the correspondence is limited.

Although all six methods purpose to measure "hardness," there are at least three really different properties of materials involved.

The scratch test would give some indication of the ability of a hardened spindle to resist *abrasion*. The wearing quality of bearing surfaces, as determined by special testing machines, is more significant, but could not properly be termed hardness.

[8]

The drill test and possibly the file test would indicate the relative ease with which a crankshaft could be *machined*.

Indentation by a steel punch, and the scleroscope and Brinell tests would measure the *compression* hardness of a steel anvil.

Typical hardness numerals for *cast iron* are given for those methods whose results can be converted into significant figures. A higher numeral by any one method would mean a harder material.

Cast Iron

Bauer drill test.....	2.29
Indentation by steel punch	250
Scleroscope.....	33
Brinell (by diameter)....	172

It is unfortunate that no one method is applicable to all engineering materials. A hardened steel which scleroscoped 73 had a Brinell numeral of 601, indicating great compression hardness; but a glass which scleroscoped 95 would crush under a fraction of the Brinell pressure. A rubber eraser scleroscopes 35, but manganese steel, which is too tough to take the drill test, scleroscopes only 25.

The kind of hardness test made should, if possible, be governed by the use for which the material is designed; and the one who passes upon the results should know how to interpret them in terms of serviceableness of the material.

Grinding Wheels

Although abrasives do possess different degrees of hardness by the scratch test, and do possess different degrees of cutting temper, the wheel man considers none of these properties when he speaks of the hardness or grade of a grinding wheel.

An R wheel is of a harder grade (by the Norton designation) than a Q wheel, by virtue of a greater strength of bond which holds the abrasive grains together. When a grading tool, similar to a screw driver, is turned while the point is forced against

[MAY, 1920]



the wheel, more force is required to dig grains from the R wheel than from the Q wheel.

With a bond of the same nature in both wheels, its amount is higher in the harder wheel. Abrasive grains, dulled by grinding, will not be torn out as readily from the R wheel as from the Q wheel, and the first wheel is said to "act harder."

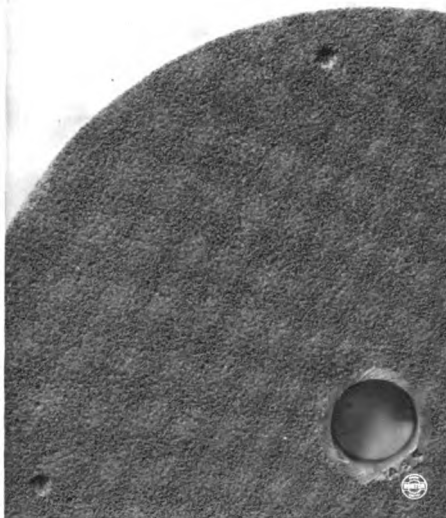
When wheels are made, a comparatively hard or a comparatively tough abrasive can be put into either the harder or the softer wheel.

One peculiar relationship between hardness of work and grade of wheel deserves mention. When the experienced grinding machine operator goes from soft to hardened steel, he puts on a wheel of softer grade, although he may continue using the same kind of abrasive. There are two reasons why this should be done.

1. The harder steel will dull or glaze an abrasive grain more rapidly than will the softer steel; so a softer grade of wheel, which does not hold its used grains as long, is employed.

2. The hardened steel, being somewhat brittle, is not as tough as the soft steel and has less tendency to pull the worn abrasive grains out bodily.

Hardness of the work being ground determines also to a certain extent the temper, as well as grain size of the abrasive best suited to that work. (See "How Physical Properties of a Material Affect



"Close Up" of a Grinding Tool Mark on a Grinding Wheel

Grinding Action," "Grits and Grinds," August, 1919.)

Alundum and Crystolon abrasive grains are so much harder and are so much different in other respects than the metals they grind, that it is of little use to compare their hardness numerals. By the scratch test, Alundum is slightly harder than sapphire (9) on the Mohs scale. Crystolon is appreciably harder than Alundum and is also more brittle.

Unless a protection hood is properly designed, it might be worse than no protection at all, as it would give a false sense of security to the operator, which would not be overcome until a wheel breakage actually occurred. A hood must be strong enough to retain the parts of a wheel which might break, not only at normal speed, but at an overspeed of considerable margin.



Factors Affecting Grinding Wheel Selection

By W. T. MONTAGUE

The selection of a grinding wheel for a given job involves—first, consideration of a set of more or less fixed conditions that the wheel must fit into; and second, careful attention to influential factors capable of modification or change to suit the conditions.

These factors might be grouped as follows:

Given Conditions

1. Material
2. Shape and Dimensions of Work
3. Contact
4. Type of Grinding Machine

Variable Factors

1. Wheel Speed
2. Work Speed
3. Condition of Machine
4. Personal Factor

1. The nature of the material to be ground, that is, whether of high or low tensile strength, generally determines the type of abrasive to be used. Steels and materials of high tensile strength usually require an aluminous abrasive, and materials of low tensile strength call for a silicon carbide abrasive.

2. The shape and dimensions of the work, in cylindrical grinding especially, have some effect on the width of wheel to be employed. Short, stiff work can often

be ground with a wide wheel by feeding straight in. Long, slender work has to be traversed with a somewhat narrower wheel and steadyrests must be used.

3. Contact exerts an important influence on work speed. In general, the broader the contact in precision grinding operations, the faster the work should travel, in order to have the wheel cut properly. Contact also affects the grade of wheel to be selected for a given operation. Narrow contacts call for harder grades than broad contacts.

4. The type of grinding machine exerts an important influence on the grain and grade to be used. For instance, in plane surface grinding, there are planer type machines employing the periphery of a straight wheel or the rim of a cup wheel; rotary machines employing the periphery of a straight wheel or the rim of a cup wheel; and vertical spindle machines. Each type of machine creates grinding conditions which are only understood after long experience in grinding wheel selection.

Space does not permit a discussion here of the effect of the four variable factors listed above. But they are influential in affecting wheel action, and hence must be properly understood and taken into account in all grinding wheel recommendations.

Notes from the Files of the Sales Engineering Department

0115 Treatment

In a great many foundries snagging machine operators throw crude oil on castings from which considerable material is to be removed. To eliminate the necessity for this, Norton Company has developed a treatment which is called the 0115 process. During the operation of an 0115 treated wheel, lubricant collects at the point of contact and on account of its consistency does not "throw off" on account of centrifugal force. This is a very satisfactory wheel to use in foundries where oil is used on the castings, and in some cases there is a resultant improvement in the life as well as the cutting action of the wheel.

Effect on Wheel Life of the Use of Hard Grade Wheels

Increasing the hardness of a wheel does not necessarily increase the wheel life. In fact, it can considerably shorten it, if the operation is such that a wheel dresser has to be used. We have had a good illustration of this recently where a 6636-O silicate wheel lasted 60 hours and ground 84 pieces per hour with no dressing necessary. A 6636-R vitrified, on the other hand, lasted only 41 hours and ground 73 pieces per hour and was dressed every 50 pieces. A 6646-Q vitrified wheel lasted only 19 hours, ground 90 pieces per hour, and was dressed very frequently.

Reclaiming Alundum Polishing Grain

When large quantities of Alundum grain are used for polishing, it may be of material advantage to the user to reclaim the abrasive. This can be accomplished by gathering up all the grain that has been

used, boiling it in a tank containing a solution of water and 10% of muriatic acid. After boiling wash thoroughly, dry, and bake it immediately in some kind of a furnace. It may be heated to red heat without injury to the grain.

After drying, the grain should be screened to the proper size and then run over some sort of a magnetic separator to remove the particles of steel or other magnetic material with which it may have become contaminated.

Crystolon Versus Alundum Wheels for Snagging Gray Iron

Silicon carbide abrasive wheels will be found more efficient than aluminous abrasive wheels for snagging gray iron castings. Wheels of soft grade made of aluminous abrasive may cut as rapidly as a silicon carbide wheel, but will wear much faster.

The results of a recent test show how a grain 24 grade Q Alundum vitrified wheel compares with a 24 grade R Crystolon vitrified wheel for snagging medium size gray iron castings. They were of an average size so that the tonnage figures give a good indication of the work each wheel turned out. Wheels used were 16 x 2½ x 1½" and the work paid for on a piece-rate basis.

Wheel	Weight of Castings Ground, Lbs.	Life, Days	Production Per Day, Lbs.
24Q Alundum Vitrified	131,988	32	4,130
24R Crystolon Vitrified	154,302	30	5,150

The Crystolon wheel, which was one grade harder, cut about 25% faster and turned out 16% more work than the Alundum wheel. If overhead was considered, it would be found that the grinding cost was greatly reduced by using the Crystolon wheel.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

Tool Making by the Lumsden System. Machine Tool Review, January-February 1920, page 12. This article urges the establishment of a central tool department in large factories and shows how it increases quantity and quality of tool production. The article describes the Lumsden oscillating tool grinder.

Pistons for the Fordson Tractor. American Machinist, March 25, 1920, page 675. An account of the main operations on the Fordson piston. This article closes with the statement that *no grinding* is allowed in finishing the pistons.

Sanford Precision Centerless Grinding Machine. American Machinist, March 25, 1920, page 696. An account of the operation of this grinding machine which is marketed by Russell, Holbrook & Henderson, Inc., 30 Church St., New York, N. Y. This machine is built by F. C. Sanford Mfg. Co., Bridgeport, Conn.

Grinding Wheel Accidents and How to Avoid Many of Them. Safety Engineering, March, 1920, page 109. This article is prepared from the bulletins and instructions issued by the Inland Steel Co.

Adapter for Using Side of Grinding Wheel on Regular Stand. American Machinist, April 1, 1920, page 718.

The Standardization of Grinding Machine Classification. American Machinist, April 1, 1920, page 736. This article shows the endeavor of the engineers of the Bureau of Construction and Repair in the Navy Department to get logical

and understandable definitions for the different kinds of grinding machines. **Mummert-Dixon Portable Radial Grinding Machine.** American Machinist, April 1, 1920, page 746. Description of a grinding machine being placed on the market by the Mummert-Dixon Co., Hanover, Pa.

No. 4 Badger Grinding Machines. American Machinist, April 1, 1920, page 748. Very brief description of a new grinding machine made by the Badger Tool Co., Beloit, Wis.

Grand Rapids Tap-Grinding Machine. American Machinist, April 1, 1920, page 751. Brief account of a new grinding machine added to the list of the Grand Rapids Grinding Machine Co., Grand Rapids, Mich.

Turning a Ball on a Rod, and a Radius Dressing Device. American Machinist, March 11, 1920, page 574. A description of a radius dressing device for grinding wheels.

Holding Device for Grinding Cam Periphery. Machinery, March, 1920, page 662. Description of a holding fixture which was designed and successfully used for grinding the periphery of a cam.

Grinding Attachment for Bench Lathe. Machinery, March, 1920, page 664.

Manufacture of Artificial Abrasives in the Electric Furnace. Journal of the Society of Chemical Industry, February 28, 1920, page 41T.

Surface Grinding; an Accurate and Economical Process in Repetition Manufacture. Engineering Production, February, 1920, page 69. A description of the methods of operating surface grinding machines and of the various means of holding the work.

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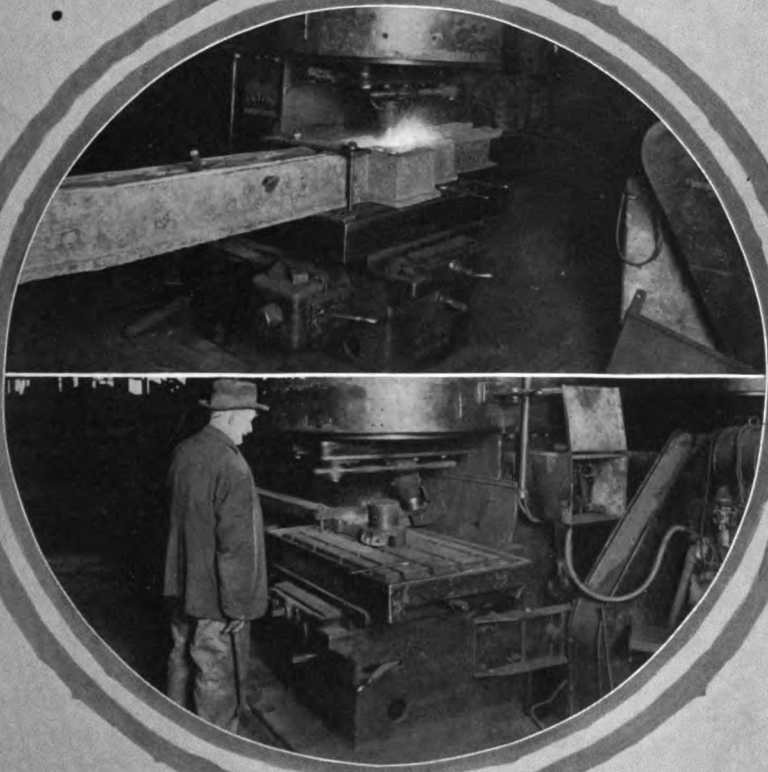
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GRITS and GRINDS

JUNE 1920



Frog and Switch Grinding



Grits and Grinds

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Methods of Judging the Efficiency of a Grinding Wheel

By R. M. JOHNSON

Grinding wheels cannot be accurately compared without keeping records of their action. An operator may report favorably on a snagging wheel, for instance, because it is easy to grind with; in other words, the wheel acts soft. On the other hand, the man who is paying the bills may object to this same wheel because it wears too rapidly. To one, therefore, the wheel is satisfactory, whereas to the other it has very little to recommend itself. Proper records would indicate just how this wheel compares with others, considering all conditions affecting the use of the wheel.

Wheels for different kinds of grinding cannot be judged in the same way. Characteristics which are very desirable in a wheel for cylindrical grinding may make a snagging wheel absolutely unfit for use. At least three classifications of grinding are necessary for our discussion:

1. Off-hand grinding such as snagging
2. Precision grinding
3. Miscellaneous grinding

Off-Hand Grinding

By snagging is meant the rapid removal of excess metal from castings by means of

a grinding wheel. Our remarks are applicable to steel, cast iron, malleable, and in fact any metal castings. The most important factor with regard to a snagging wheel is *how much does it actually cost to grind a unit of the material? The finish is not important.*

The total grinding cost includes wheel cost, labor cost, and overhead. It is not a fair comparison if labor and wheel cost are used alone, because overhead is the big item. Overhead per unit of time is constant, whereas overhead per unit ground varies and depends on the production. The higher this production, the lower the overhead per unit. The total grinding cost per hour is not so important as the actual cost per unit of production.

To get this figure one must know wheel cost, labor cost, overhead per hour, wheel life, and production.

Wheel Life

This figure is in itself unimportant because from it no idea of the production can be obtained. The true cost per unit cannot be calculated and the result may be absolutely misleading. If two wheels are compared on the basis of life alone, the result



is that the wheel with the longer life is reported as better for the work.

Ask the operator for his opinion and he will many times report that the wheel which wears out the more quickly is the more satisfactory. His reasons are that it cuts faster than the wheel with a long life and he does not have to exert as much pressure in grinding.

Of course the wheel life should be reported, but this figure should be used only in conjunction with other data.

Production

The production is the important figure. Combined with the wheel life it is possible to figure overhead charges and, with this information, total grinding cost per unit.

Production can be obtained in several different units:

1. Pounds of material ground off
2. Number of castings ground
3. Tonnage of castings ground

The first method can be applied to any type of casting. Both large and small castings can be compared on this basis because the actual material removed is measured. The second and third methods are not as satisfactory because another variable, the size of the castings, is introduced. If castings of the same type and size are being ground, either the second or third method is satisfactory. If the size varies greatly, the third method is better than the second, although either gives only an approximation.

Total Grinding Cost

From the production per hour, the wheel life and the operator's wages, the overhead, the wheel cost, and the labor cost per unit ground can be calculated. Thus the total grinding cost per unit may be figured.

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Example

In this calculation it is assumed that each casting ground was of uniform size and had practically the same amount of metal removed.

Wheel cost	\$7.00
Labor (piece rate)	.. 0.10 per casting
Overhead	 1.00 per hour

Wheel life	 20 hours
Production	 200 castings

Total Cost Calculation

Wheel cost	 \$7.00
Labor cost (.10 × 200)	 20.00
Overhead (1.00 × 20)	 20.00
	\$47.00

Unit Cost Calculation

\$47
— = \$.235 per casting
200

This is a correct method of comparing snagging wheels. Any other method is merely an approximation and may give incorrect figures and, in fact, conclusions which are not in keeping with the actual facts.

Precision Grinding

This class includes production grinding to close limits on precision grinding machines. External cylindrical, internal, and surface grinding are all in this class. For a clear and simple discussion, it is a good plan to divide precision grinding into roughing and finishing and consider them separately as types of grinding.

Roughing

Roughing wheels must be of such structure that stock can be removed rapidly, finish being of no importance. As in the case of snagging, either the cost per pound of metal ground off or the cost

[3]



per unit of production is the all-important figure. In such a calculation, the wheel cost, labor cost, overhead, wheel life, and total production must be determined. There is an additional item of importance which must be considered—the diamond cost.

All of the figures, with the exception of the total production and diamond cost, are similar to those recorded for snagging wheels.

Production

When wheels are used throughout their life on the same kind of work, such as roughing crank and cam shafts, pistons, and, in fact, any piece which is standard, the number of pieces ground is usually a satisfactory production figure. This is because each has practically the same amount of stock to be removed, so that the number of pieces ground is nearly a measure of the total amount of material removed—the best unit in which production can be obtained.

If the wheels are used for a variety of work, it is impossible to obtain a correct production figure except by going to a great deal of trouble. Cost per unit, therefore, cannot be obtained; and consequently it is necessary to compare wheels on a different basis. This will be discussed later.

Diamond Cost

There are some jobs where the unit diamond cost is larger than the cost of the grinding wheel. On grinding standard parts, diamond cost can be obtained easily over a period of time and from this the cost per unit calculated.

Total Grinding Cost

The total cost per unit is obtained just the same as for snagging castings except that the diamond cost must be added to the figure.

[4]

Roughing Wheels Used for a Variety of Work

The cost per unit ground cannot be obtained without keeping detailed records which would have to be so comprehensive that the expense would probably not be justified. These wheels must be compared on a different basis.

Assuming that the wheels are cutting satisfactorily, there are two factors which should be considered; wheel life and the amount of dressing necessary—two figures which are closely related, for the wheel which needs least dressing usually has the longest life. The best wheel would be the one with the longest life and fewest dressings, bearing in mind the assumption that the wheels are considered equally desirable from the cutting standpoint.

Finishing Wheels

The finish obtained with a finishing wheel determines the use of that particular wheel for this class of work. After the desired finish is obtained, the wheel which will produce this finish at the lowest cost per unit should be found and used. Such a choice can be determined in exactly the same way as when determining upon the best roughing wheel.

Miscellaneous Grinding

The classification of miscellaneous grinding includes tool and cutter grinding, general off-hand grinding, and any other operation where production is not important. For work of this type it is impossible to get comparative figures, the operator's opinion of the wheel action being in nearly all cases the deciding factor.

For tool, cutter, and drill grinding, finish is important, for the cutting edge must be keen and there must be no burning. The actual amount of stock removed per wheel is not of fundamental import-

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ance, although naturally, if finish and rate of cutting are the same, the wheel having the longest life should be chosen.

The wheels for off-hand grinding jobs are chosen, not because they last longer, but because they fulfill certain special requirements. A wheel may be used for squaring the ends of rods. Such a wheel must hold its shape so that constant dressing is unnecessary. In most cases a little burning would not be objectionable. On the other hand, for sharpening lathe and planer tools, the wheel must

cut cool and the finish must be rather good.

Summary

When judging the action of a wheel, or when comparing test wheels, conclusions should not be formed without considering just what the wheels should be doing. Should they be grinding metal rapidly and at low cost or should they be finishing a piece beautifully regardless of production or cost? The answer to this question will suggest the basis on which wheels should be compared.

Wheel Speeds

By W. T. MONTAGUE

The Relation of Wheel Speed to Wheel Hardness

In the July 1919 edition of "Grits and Grinds," there was an article on the speed of grinding wheels, in which it was stated that "the grinding wheel is revolved chiefly to distribute the work of cutting over its entire face."

In general, we know that a soft wheel revolving rapidly will produce more than a hard one revolving more slowly. This is true because the more open structure of the soft wheel provides greater clearance for grinding chips, and this gives a freer and cooler cutting action. Theoretically, therefore, the correct speed for grinding wheels is the safe maximum speed at which the wheel may be operated.

In actual practice, however, certain ranges of peripheral speed have been found to give good results on certain classes of ground work. For example, a satisfactory wheel speed for sharpening planer knives is around 3,500 surface feet per minute; for off-hand snagging of

castings, 5,500 surface feet per minute; for cylindrical grinding of crankshaft pins and bearings, around 6,000 surface feet per minute; and for cutting off hardened and high speed steel, tubing, and the like the proper speed approximates 9,000 or 10,000 surface feet per minute.

These speeds have become quite well established in the shops of this country to-day. Many times peculiarities in machine design may have been partial determining factors in the operating speeds of certain types of grinding machines. In surface grinding, lower wheel speeds are used than for cylindrical, because mechanical limitations usually prevent the work table being traversed fast enough to keep the wheel face opened up and free cutting. But, generally speaking, certain grits and grades of wheels operating under these speed conditions have given good results. And as the grit and grade of a wheel are the chief means of its identification, certain narrow ranges of grade have become to be known as more or less standard for given grinding operations.



The point we wish to make is that wheel speed and wheel grade are closely tied together in the success or failure of any grinding wheel used in off-hand operations. For cylindrical grinding, however, this does not apply because of the variety of work speeds available which take the place of variable wheel speeds. In the case of the operations mentioned above, the grade was made to suit the standard speeds decided upon. Hence, when a given grade of grinding wheel is recommended for a certain operation, this recommendation is based on the assumption that the generally accepted speeds will be employed. Obviously, the grinding wheel manufacturer must have some peg to hang his hat on. There are so many variants entering into the problem that speeds must be standardized in order to specify grade intelligently.

The Effect of Wheel Speed on Cutting Action

It is quite generally thought that the faster a grinding wheel revolves, the greater its productivity in a given time. This is not altogether true in precision operations, as in cylindrical grinding for instance. It is only true to a limited extent in off-hand grinding, like the snagging of castings.

In cylindrical grinding, the production of a given wheel is determined by the depth of cut, table traverse, and diameter of the work. Hence, the controlling and limiting factors are rigidity and general sturdiness of the grinding machine to permit of deep cuts, and the traverse speeds of the table or wheel, if the wheel head travels instead of the work table.

Increase of wheel speed in cylindrical grinding changes the size and shape of the chips cut off. In this case, the rate of production is not greatly affected, unless the higher speed permits the use of a softer wheel, which might cut more freely. But

for a given wheel there is no difference in production, whether 4,500 surface feet per minute or 6,500 surface feet per minute is used, provided the grade or the work speed is adjusted to these different wheel speeds.

In off-hand grinding operations, we have a somewhat different condition. Here the grinding may be said to be done under constant pressure as contrasted to constant feed in cylindrical grinding as just described. For example, if a bar of metal is pressed against a revolving wheel face under a given pressure, it is obvious that the faster the cutting grains come around, the quicker will succeeding sections of the bar be cut away. But in practice, this is only true up to a certain speed; for if the grade of a wheel is correct for a speed of 5,000 surface feet per minute, there will soon come a point, if its speed is increased, when the wheel face will begin to glaze over, thus reducing its cutting capacity.

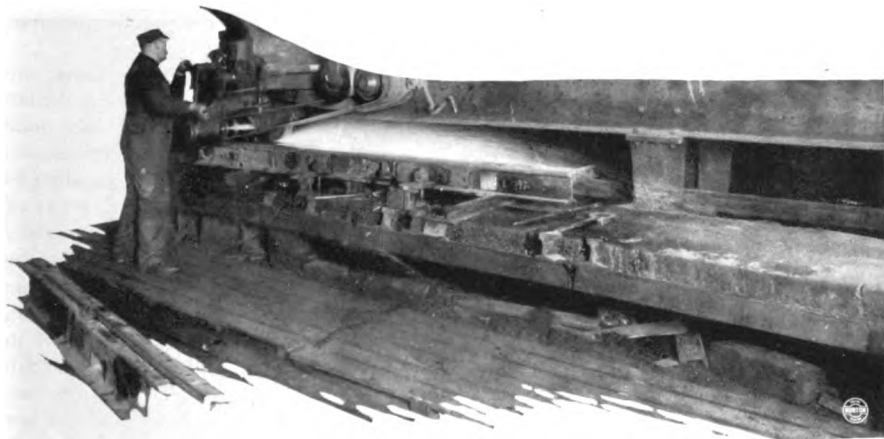
Nothing is really gained from increasing the wheel speed in off-hand grinding over the generally accepted range, unless wheels softer than those usually recommended are employed. And the extremely severe service to which many wheels are put in off-hand grinding discourages the use of soft grades.

From the foregoing, we might conclude that:

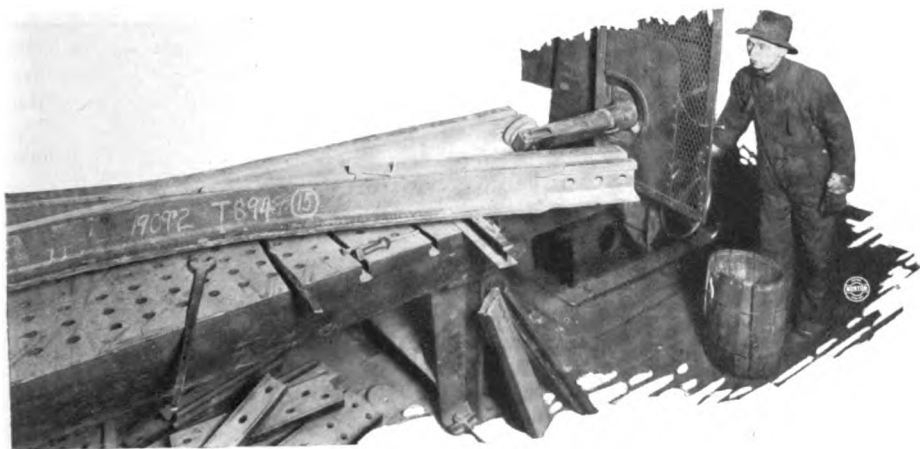
1. The grade of hardness to be recommended for a given grinding operation depends upon the surface speed of the wheel.
2. The grinding wheel should be as soft as is feasible for the operation and whenever possible operated at the high end of the recommended range of speeds.
3. For a given wheel used for precision grinding operations, not much increase in production is to be expected from increasing the speed of the wheel alone.
4. The logical way to increase production in precision grinding operations is to increase the traverse of the work past the wheel or the depth of cut of the wheel.



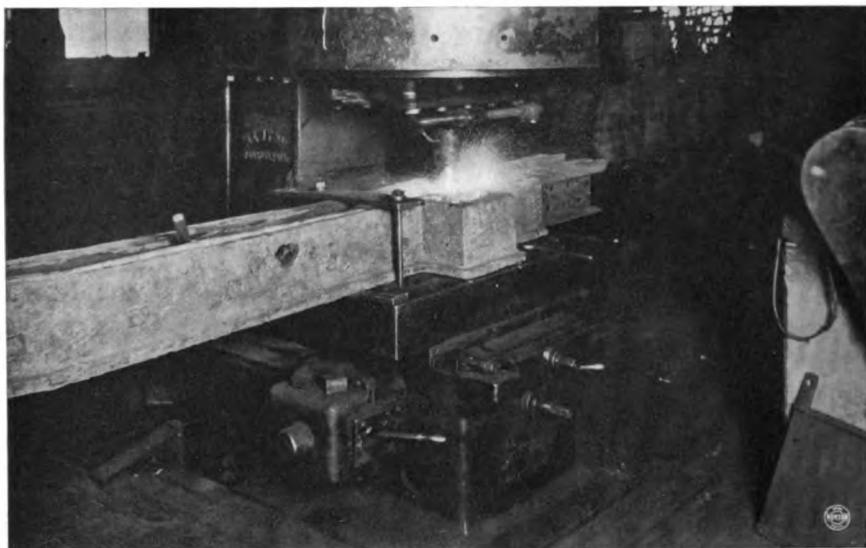
Frog and Switch Grinding



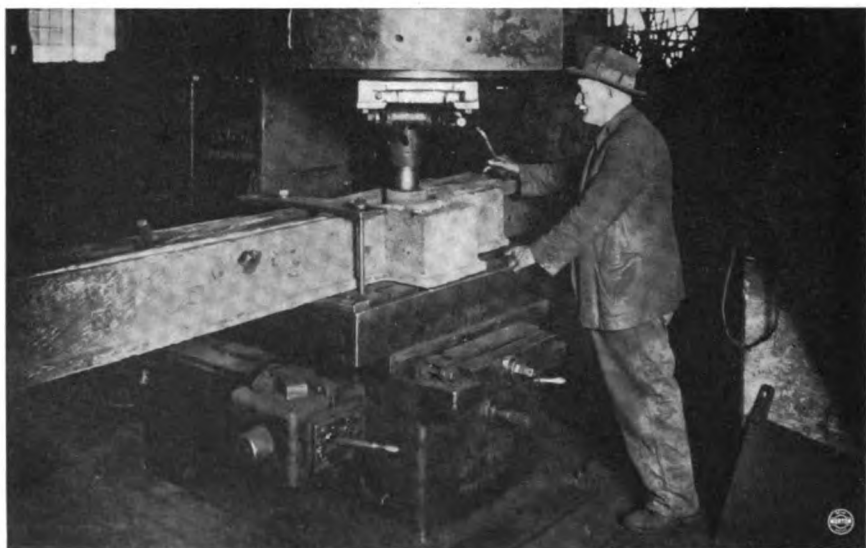
The above illustration shows a manganese steel frog being surfaced on a planer type machine. A cut of .004 to .007 deep is made and a table traverse of 10 feet per minute is possible. To insure ample power for the grinding wheel a 30 H. P. motor is used. There are two operations. For finishing the tread surface an Alundum 14 O wheel is used. For grinding the grooves an Alundum 16 Q proves satisfactory.

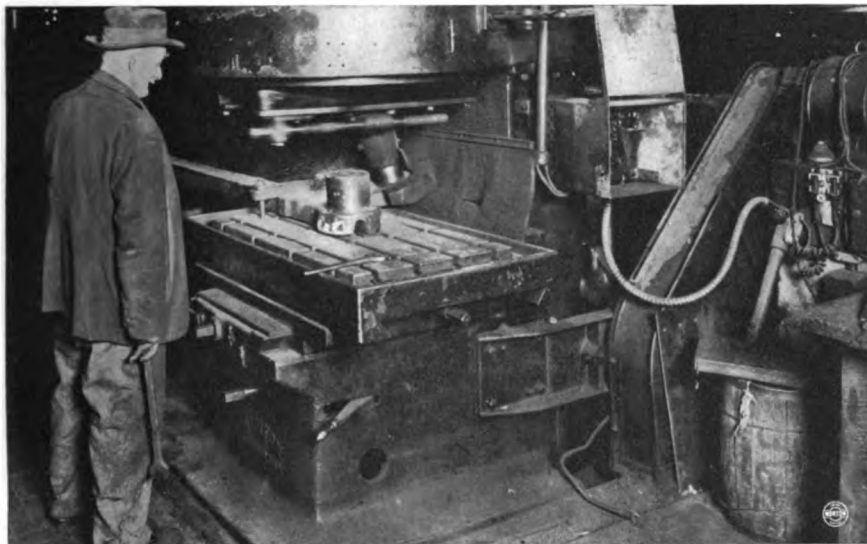


Showing the grinding of the crotch of the switch. This machine imparts a horizontal movement to the wheel spindle which grinds to gauge the various elements of the crotch.



In these pictures a special machine is shown grinding switch-pin bearings. This particular job is virtually an internal grinding operation on which an Alundum wheel 24 K shows highly satisfactory results.





The same machine as shown on the previous page is used for grinding the switch pin. This pin is the fulcrum of the switch tongue and fits the bearing ground in the body of the switch. Operations on both bearings and pins are semi-precision in character and are held to limits by gauges.

(The above pictures were taken at the William Wharton, Jr., & Company, Inc., Easton, Pennsylvania.)

Notes from the Files of the Sales Engineering Department

GRAINING LITHOGRAPHIC PLATES

Lithographing from metallic plates has often been unjustly condemned because the plates used were improperly grained. There is really no mystery surrounding

this graining operation, if the proper type of machine, size of marbles, and good quality of abrasive are used. Quartz sand with flint was formerly used for this work

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[9]



and is still used in some places. However, more recent developments have shown that the artificial abrasives, Alundum and Crystolon, are much more efficient for this particular operation.

Equipment

Most machines consist of a flat table from 6' to 8' square so arranged that it can be shaken back and forth in a horizontal plane at a rate of approximately 200 oscillations of about 2" length per minute.

Small spherical balls from $\frac{1}{2}$ " to 1" in diameter, the most common being $\frac{3}{4}$ ", made of marble, stone, imitation agate, or steel, are used for this operation. They wear very slowly and can be used for a number of years.

The zinc or metallic plates range in size from 15 x 18" up to as large as 33 x 44".

Operation

The operation consists of removing the impression left on the zinc or metallic plate, preparatory to renewing the "photo engraving" process.

About two quarts of abrasive, or less, depending upon the size of the plate to be grained, is sprinkled over the plates as they lie flat on the table. A small amount of pumice powder may be added, this also depending upon the surface required on the plate. On top of this grain quite a large number of marbles are placed, using any one of the types mentioned above. The most common in use at the present time are the steel marbles. They will last a great many years. Water is then sprinkled over these marbles, grain, and plates, and the machine is started in operation.

With a good sharp cutting abrasive the operation requires from 20 to 35 minutes, depending upon the size of the plate being grained.

Very often a number of plates are placed one on top of the other and as soon as one plate is finished it can be removed, allowing the marbles and abrasive to run onto the next plate. The machine can then be started in operation and this procedure continued until four or five plates have been grained, thus using the same abrasive a number of times.

It is only a matter of experiment and a little judgment on the operator's part, to determine just when the desired graining finish is reached.

Abrasives Used

Different classes of lithographic work require different finishes. If the plates are intended for turning out posters, such as might be used for advertising a circus, much coarser grain can be employed than for preparing plates which are used for bank notes.

For the rougher graining very good success has been experienced with either Alundum or Crystolon ranging in sizes from 70 to 120. The Crystolon grain has in most cases proved a little more satisfactory than Alundum. Sometimes a mixture of 70 and 120 Crystolon giving a combination which works similar to 100 grain size gives very good results for the rougher plates.

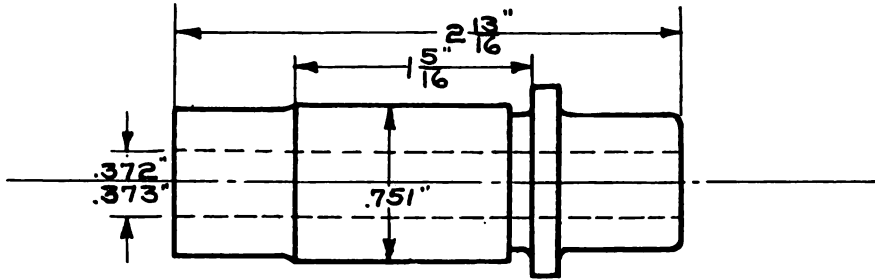
For a medium finish very good results have been experienced with 150 Crystolon abrasive.

For plates which require a fine graining we can strongly recommend 200 Crystolon abrasive, or at times where an extremely fine graining is required 220 Crystolon has been employed with good results.

The Sales Engineering department will be glad at any time to co-operate in furnishing suitable materials to concerns who do this graining work and will be glad to send samples for examination or trial purpose.



Two Examples of Production with Norton Cylindrical Grinding Machines



Valve Guide Bushings (cast iron)

Previous Operation—rough turned

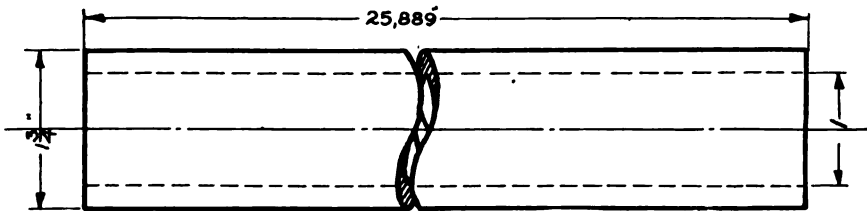
Stock removed—.023"

Machine—6 x 32", Type A

Wheel—Crystolon, 14 x 2 x 5, Grain 36, grade K

Limits— $\pm .0005$ "

Production—175 to 187 per hour



Typewriter Platen Roll (hard rubber)

Limits— $\pm .005$ "

Machine—6 x 32", Type A

Wheel—Crystolon, 14 x 2 x 5", grain 36, grade J

Production—20 per hour



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues

Internal Lapping and Laps. *American Machinist*, March 18, 1920, page 600. At the end of the article the writer presents the question of terminology in relation to grinding, lapping, and stoning. What do these terms mean to you?

Some Operations on Caramel Knives. *American Machinist*, March 18, 1920, page 601. The method of truing the grinding wheel and the grinding operation are described carefully. The production on the oil-stoning operation, the most particular one of the processes, was doubled by the use of the device which is illustrated and described at the end of this article.

How Precision Gage-Blocks Are Made. *Machinery*, April, 1920, page 697. This article explains just how precision gage-blocks are made by the Pratt & Whitney Co., Hartford, Conn. Several grinding operations are described and illustrated. German Cutlery Manufacturing Practice. *Metal Industry*, April, 1920, page 172. Abstract of a lecture before the Sheffield Cutlery Trades Association. The grinding and polishing operations are compared with those of English manufacturers.

Appliances and Operations in the Grinding of Valve Gear Links. *Railway & Locomotive Engineering*, April, 1920. This article tells how the radii on links used on valve gears in use on locomotives are finished on the Hammett link-grinding machine.

Band Wheel Grinder. *Wood-worker*, April, 1920, page 52. The grinding is

accomplished by rotating the band wheel past a fixed abrasive stone. The grinding machine illustrated is made by the GeBott Manufacturing Co., Big Rapids, Mich. Marschke "Economy" Motor-Driven Grinding Machine. *American Machinist*, April 15, 1920, page 860. Brief description of a grinding machine made by the Marschke Manufacturing Co., Indianapolis, Ind.

Diamond Face-Grinding Machine and Its Work. *American Machinist*, April 22, 1920, page 877. This article describes and illustrates the magnetic chuck, the segment wheel, the rotary device, and the pulley-grinding fixture which are used on the large face-grinding machines made by the Diamond Machine Co., Providence, R. I. Chilled cast-iron plates are ground satisfactorily on this machine.

Machine for Grinding Small Taps. *Iron Age*, April 29, 1920, page 1251. The Grand Rapids Grinding Machine Co., Grand Rapids, Mich., has placed on the market a machine designed for taps ranging in size from as small as No. 6 machine screw to a maximum of 1-inch diameter plug taps.

Design of Sub-Presses. *Machinery*, May, 1920, page 841. The method of making pillar-type sub-presses is described and the grinding operations briefly outlined.

Internal Grinding Fixtures. *Machinery*, May, 1920, page 870. Detailed description of a fixture designed for holding delicate work during internal grinding operation.

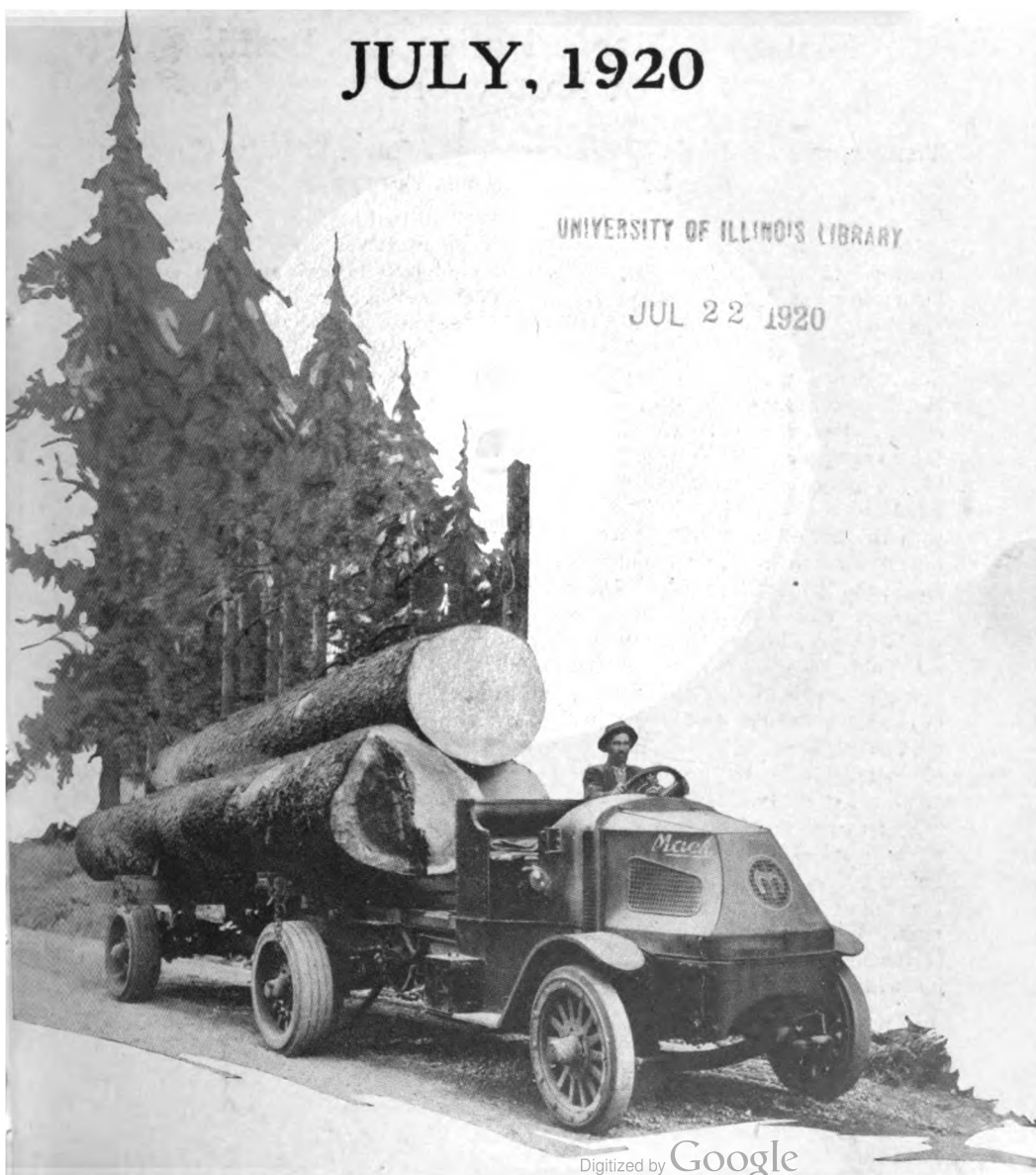
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Grinding Magic Builds the Bulldog of Motordom

The Layman Records His Impressions After a Visit in the Plant of a Large Auto Truck Company

No one can think of the twentieth century and its modern inventions which have made possible the efficiency and speed of the present day without including in his train of thought the modest, but thoroughly necessary medium for creating exactness to the smallest fraction of an inch—the grinding wheel.

The every day necessities and luxuries of the present time which the Aryan-inhabited portion of the globe look upon with the unconcern of long experience—the mechanic's tools, the heavy work truck, the lighter motor car designed for pleasure, and the phonograph—could not be supplied in the vast numbers which the public demand nor could they be manufactured with such finished efficiency of mechanism and at such a rapid rate of production, were the fundamental means of manufacture—the grinding wheel—an absent quantity.

As an example of the important work of mechanical creation in which the grinding wheel plays an important part, the motor truck stands in prominent rank. Without doubt the manufacture of the motor truck is one of the most important enterprises of the present day,

which demands fast transportation of material to market and the durability of the carrier.

Largeness of construction in the modern vehicle signifies by no means that the product can be turned out in a roughened, haphazard manner. Where the requirements are durability and reliability of service, there has to be a certain measure of exactness in the fitting of the parts, so that the interior of a "bulldog" truck designed to haul raw materials in five-ton lots must have something of the nicety and the perfect relationship of one part to another which are required in the finely running timepiece.

Grinding has done three things for the motor truck—it has made possible its high standard of accuracy; it has revolutionized the methods of manufacture and thus aided materially in the speed with which the truck can be produced; it has lowered manufacturing costs.

At the International Motor Company, Plainfield, N. J., where the Mack truck is manufactured, grinding has long since proved its right as a fundamental of manufacture and daily applications of the abrasive wheel according to enlightened



grinding methods have caused the laborious processes of the past day to be thrown on the scrap heap of discarded ideas.

Where formerly drill presses bored the cylinders, where an old type of lathe did the turning, where an open fire, a pair of tongs, and a pail of water made up what might be called the "heat-treating" and "hardening" departments; where a simple grindstone, worked by dint of enlarged muscles and a strained back, constituted the "grinding department," the modern grinding wheel of various sizes, grains, and grades—depending upon the type of work to be done—plus the application of a few scientific principles has succeeded.

Grinding figures in the manufacture of the Mack truck at practically all points of its construction. Perhaps the first direct application comes in the snagging of castings and forgings. Quantities of cast iron, malleable iron, steel, bronze, and aluminum pass through the snagging department all the time and on the various snagging jobs both Alundum and Crystolon wheels are used. The snagging job illustrated in figure 1 shows the cleaning of exhaust manifold castings for type AB Mack motors. On such a job an Alundum wheel, grain 20, grade Q, 6" diameter and 1" face, is used on a portable pneumatic grinding machine. This wheel runs at 3,000 r. p. m.

Another of the rougher jobs of grinding is shown in figure 2—the grinding of steel connecting rods. This is a case where the grinding wheel proves its claim of making possible rapid production. No less than 1,800 of these rods are handled every eight-hour shift. The wheel used is an Alundum 24-Q, 14" diameter.

All the way through the manufacture of the various parts of the Mack truck grinding enters directly or indirectly—



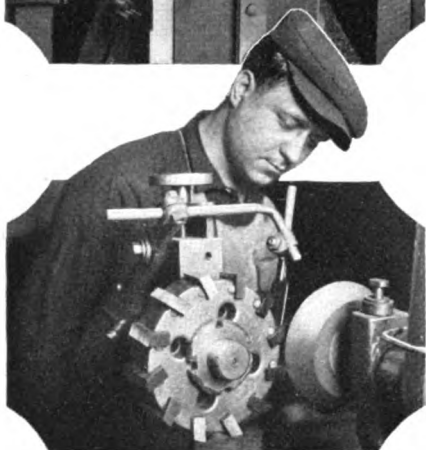
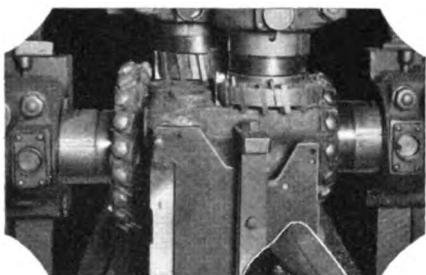
Figure 1—Snagging Operation—Cleaning Exhaust Manifold Castings for Type AB Mack Motors



Figure 2—Cleaning up Drop Forgings with an Alundum Wheel 24-Q, 14 in. diameter by 2 in. face

but always importantly. An example of the indirect, but vitally necessary, rôle of the grinding wheel in this industry is furnished in the milling operation illustrated in figure 3. On this milling machine four milling cutters are operating simultaneously on three faces of a cylinder casting. The 62 teeth of these four milling cutters must be kept sharp, and the operator with his grinding wheel is on hand to take care of this important detail (figure 4).

Entering more directly into the building of motor trucks are a number of grinding operations of an extremely varied character—the smoothing of the caulked joints on the side frames; on cab construction; the smoothing of the sheet steel with which the inner surface of the body is



Figures 3 and 4—Sharpening the Teeth on the Four Milling Cutters



Figure 5—Smoothing the Caulked Joints with Norton Wheels in the Frame Department. The Operation is Performed with Pneumatic Grinding Machines

covered. All these grinding jobs might be termed of a finishing character, where rough edges and surfaces must be smoothed, imperfections removed, and screw heads, burrs, and sharp edges ground down level with the surface. (See figures 5, 6, 7 and 8.)

But it is not only the Norton wheel which plays an important part in the grinding drama. There is the Norton grinding machine, the use of which enters in a large number and variety of interesting grinding operations, one of the most important being the fashioning of what is considered by many the most important part of the Mack motor—the grinding of the crankshafts.

This part of the Mack motor has what are believed to be the largest main bearings of any crankshaft built for motor truck engines. It is casehardened and registers not less than 80 under the scleroscope test—another distinctive feature. The material is open-hearth, drop-forged steel of .10 to .20 carbon content and offers a problem in grinding. The rough turning operation leaves .050" in diameter for grinding, of which .035" is removed in the rough grinding operation, and .015" in the finish grinding. Both grinding operations are done on a Norton 16 x 72" grinding machine equipped with Norton 24 combination K wheels. The grinding limits are plus or minus .005". (Figure 10.)

The operation next in order in the building of the truck is the grinding of the four crank pins. This work is done under conditions similar in all respects to those of the main bearings. The machine used is a Norton crank pin grinding machine and the pins are ground to the same limits of plus or minus .0005". (See figure 11.)

Another interesting operation in which the Norton grinding machine has shown itself of excellent service in providing

nicety of ground work is finish grinding the eight cams, removing approximately .025" of stock. The cams are ground on a Norton 16 x 50" Cam Grinding Machine equipped with Alundum wheels 36-1, 18 x 2", running at 1,100 r. p. m. The next step is the rough and finish grinding of the center and end main bearings. The operation is one of careful, minute grinding for these parts and the cams must run true to within .0005". The grinding job is done on a Norton Plain Grinding Machine, 16 x 50". The third main bearing is then rough ground, followed by the roughing of the gear seat and governor bearing without removing the shaft from the machine. The three bearings are then successively finish ground with a Norton 24 Combination wheel 24" in diameter by 3 1/4" face. Before this latter operation care is taken that the wheel is perfectly trued and the grinding is done before the shaft is removed from the machine. This insures all three bearings being concentric within the close limits set. (Figure 12 illustrates the finish grinding of the cams.)

There are two other operations of interest to the grinding man for whom the manufacture of such an example of the achievement of modern industry is a story made up of numerous chapters of grinding. These remaining operations are the finish grinding of valve lifters and the grinding of the hardened roller.

The valve lifters are made of .20" carbon steel, casehardened, and one hundred of these parts are finish ground every hour, the work being done on a "centerless" grinding machine with an Alundum wheel, 16 x 15 1/4 x 4 x 9", grain 80, grade L, vitrified process.

A stage of the grinding of the hardened roller, which is fitted to each valve lifter, is particularly interesting because two wheels are in simultaneous operation on the piece. The hole is ground with an



Figure 6 — Making Smooth the Rough Edges and Surfaces in Cab Construction



Figures 7 and 8—Some other Smoothing Operations—going over the Hood and the Body with Norton Wheels



Figure 9—Machining Cast Steel Gear Covers with an Alundum 38-30-J Silicate Ring Wheel



Figure 10 — Crankshaft Main Bearings Ground on a Norton 16x72 in. Machine with 24 Combination K Wheels

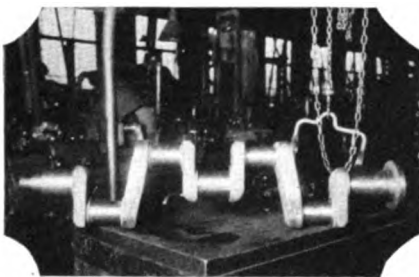


Figure 11—Grinding Four Crank Pins on a Norton Crank Pin Grinding Machine

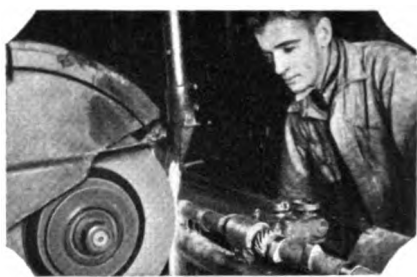


Figure 12—Finish Grinding the Cams on a Norton 16x50 in. Cam Grinding Machine

Alundum 38-80, grade L wheel, $\frac{3}{8}$ " diameter x $\frac{3}{8}$ " face. This wheel, running at 30,000 r. p. m., removes .003" metal. As the wheel feeds into the hole an Alundum 46-K saucer wheel running at 1,800 r. p. m. comes into contact with the face of the rollers, removing from .002" to .005" of material. The production is 50 rollers ground per hour. (Figure 14.)

Grinding, it may be judged, is practically inseparable from the story of the Mack truck, and without a doubt is the scientific means which has made exactness possible and brought upon the market the truck in its present high standard of durability and excellence.

The rapid growth of the grinding department of the International Motor

Company testifies to the indispensability of grinding. Six years ago there were hardly a dozen machines in the grinding department of the Plainfield plant. To-day floor space, men employed, and machines used are all tripled. Production has more than tripled. The labor-saving costs are self-explanatory to any one who understands what grinding accomplishes.

So important a phase is grinding in this modern industry that when the great new plant of this company in New Brunswick, N. J., is in full operation, other additions will have been made to their grinding equipment—even the contours on gear teeth will be ground by a new process.

The story of any great manufacturing progress is interlinked with grinding, and



Figure 13—A Hundred Valve Lifters are Finish Ground per hour with an Alundum 80-L Wheel



Figure 14—A Stage of the Grinding of the Hardened Roller which is Fitted to Each Valve Roller

since the scientific development of the fundamental industry aids in the building up of the more intricate manufacture, the value of the service which has developed grinding to its present high state recommends itself readily to the manu-

facturer. Norton Engineering Service continues to offer interesting and timely aid to that company whose problems are many and include the three all-important considerations of accuracy, production, and reduced manufacturing costs.

Grinding High Speed Steel Reamers

By G. A. PARK

During the past few years several very hard, dense steel alloys have been developed particularly for use in reamer blades, cutters, and tools. Probably most of the readers are familiar with the difficulties encountered in grinding these alloys such as checking, cracking, and distortion of the steel. We shall outline briefly, however, the experience of one plant in overcoming these difficulties.

The steel in question was a high speed tungsten alloy developed primarily to replace the Austrian "gold label" steel. It was extremely hard and dense and very sensitive to sharp temperature changes such as might occur during grinding, if special care was not used. This steel was in the form of reamer blades 1" thick, to be used in large tapered double-

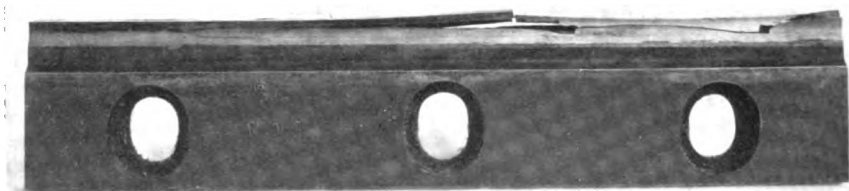
bladed gun reamers up to 6' long. The grinding was a very delicate proposition and required extreme accuracy.

After the reamers had been set up, they were ground cylindrically on a Norton 14 x 96" plain grinder to the correct taper, leaving 0.020" of surplus stock as measured diametrically to allow for lipping the cutting edge. This lipping consisted of grinding a concaved flute along the edge of the reamer blade about $\frac{1}{4}$ " to $\frac{3}{8}$ " wide and $\frac{1}{16}$ " deep.

A portable electric grinding machine was then bolted to a steel arm protruding from the safety hood of the Norton machine, so arranged that the spindle of this portable machine was at right angles to the table traverse. Wheels $3 \times \frac{3}{4} \times \frac{3}{8}$ ", grain 3846 grade K, Alundum

vitrified with a rounded face, were used on the electric grinder. An adjustable rest was inserted underneath the reamer to hold the work absolutely rigid while this lipping operation was being carried on. It was important that the reamer blade should be in the same plane as the work centers while fluting to insure an even depth to the whole length of the flute. The electric grinding machine was fed down onto the reamer blade at the rate of approximately 0.001" per traverse until the flute was properly

at the time. A number of different grains and grades were tried with every possible combination of feed, table speed, and dressing available on the machine, but the blades would invariably burn black and develop fine cracks after the table had traversed only one half of the reamer length. This happened when grinding both wet and dry; in fact, it was found impossible to grind this material wet under any conditions. A Huntington dresser was used to open up the face of the wheel with not much



High Speed Steel Gun Reamer Cracked by Improper Grinding

ground. If the original milled flute in the blade was very uneven, it was necessary to true the grinding wheel several times during the operation. Care must be taken to prevent burning the blades either through too deep a feed or glazing of the wheel face.

The electric grinding machine was then dismantled and the reamer finish ground cylindrically to as nearly perfect size as possible. The limits as measured diametrically were plus 0.00025, minus 0.000. There could be no measurable variation in the taper from one end to the other.

The next operation was that of backing off the blades and here the real difficulty arose. It was done in the same Norton machine with wheels 14 x 1 x 5" which happened to be the only size available

better results. A feed as light as 0.00025" per traverse caused bad burning. The blades would develop fine cracks which would gradually open up until pieces would break off altogether. (See cut.) Sometimes, after burning, cracks could not be seen, but the blade would break down while being used.

The wheel face did not show any signs of loading or glazing and it occurred to the operator that perhaps he was not really removing stock, but rather that the wheel was simply rubbing over the steel and generating the heat which caused burning. Therefore, it seemed a question of forcing the wheel to remove the material.

A fresh start was made and the wheel (Norton 3846-I vitrified) dressed with a Huntington dresser to a very coarse face.

It was then fed into the work 0.002" and the reamer traversed by hand as rapidly as possible. The grinding was done dry. The result was very encouraging. Not a sign of burning appeared although we had taken a much heavier cut than before. The step was repeated with the same result. Apparently the problem was solved and all of the reamers were backed off in this way in a very short time and with absolutely no burning. Of course, the wheel showed some wear to each traverse, but this was negligible as lighter cuts could be taken on the final traverses of each blade to avoid the

excessive wheel wear. An extremely fast table traverse was the real factor in eliminating the burning of the steel.

This company has since changed to the use of a 3824 grade H Alundum vitrified wheel for this backing off work.

The reamer blades were backed off to a very narrow land and afterwards honed. By mounting the whole finished reamer in a lathe and trying the blades at intervals with a bar of copper mounted in the tool post, the rubbing or honing of the edges to insure equal working capacity of the blades was readily accomplished.

Notes from the Files of the Sales Engineering Department

No. 66 Alundum

A great many tests have been run during the last few months in an effort to compare the new No. 66 Alundum abrasive with No. 38 material. In the majority of cases No. 66 has been successful. Below are listed results of cylindrical and internal grinding tests giving actual comparisons with figures reported by the customers. They can be considered as typical of a large number of similar trials, records of which are in the files of the Sales Engineering Department.

Cylindrical Grinding (Roughing)
Machine Steel Shafts
14 x 2 x 5" 6646 Grade K Wheels
Brown & Sharpe Cylindrical Grinding Machine

These shafts were 32" long x 1 1/8" in diameter, with an average of .022" or .023" to be removed. A 6646-K wheel ground 15 pieces per dressing, while a 3846-K averaged only eight. The finish was the same for both wheels.

Internal Grinding Ball Bearing Races
Hardened Steel
1 1/8 x 1 1/8 to 5 x 1/8" 6670 Grade K Wheels
Van Norman Machine

Grain 6670 grade K vitrified wheels lasted seven times as long as 3860 grade K vitrified and produced ten times as many rings. The 6670-K wheels also produced a very satisfactory finish.

If you are using No. 38 Alundum wheels and have never tested No. 66 material, write our Sales Engineering Department or speak to our representative the next time he calls.

One Reason Why the Proper Wheel Should Be Used

One of our customers had been grinding 3 1/2 x 5" pistons with a grain 36 grade N Crystolon wheel. The production averaged ten pistons per hour and about ten per dressing. By changing to a grain 36 grade L wheel, the production per hour was increased to 35 and the number of pistons per dressing increased to 32.



The second wheel cut faster because it was softer and produced more pieces per dressing. Moreover, being soft the wheel wore slightly and constantly renewed the cutting face.

Saving the Wheel by Caring for the Machine

At a plant where stoves are manufactured grains 20 and 24, grade S Crystolon vitrified wheels are used for the snagging operation. The machines are of a heavy type and kept in excellent condition. The wheel wear averages about 1.7 cubic inches per day for each wheel.

Another plant, where exactly the same material is ground with the same wheel, but where the equipment is lighter and not kept in nearly as good condition, had an average wheel wear of 3 cubic inches per day for each wheel. By using a wheel one grade harder or grade T the wheel wear was reduced to 1.7 cubic inches per day per wheel, comparing favorably with that at the first plant.

Vibration caused by loose bearings

always results in excessive wheel wear unless harder wheels are used. The hardness of the wheel, however, cannot be increased indefinitely to counteract poor machine conditions as decreased production results.

Care of Polishing Wheels

A recent report informed us that Alundum polishing grain cut well when the wheel was first set up, but that it soon lost its cut and did not stick on the wheel satisfactorily. One of our demonstrators examined the rag wheels which were being used and found that they had previously been used for an oil finishing operation and the oil and grease had not been completely removed from the surface.

The oil prevented the glue from holding on the wheel and of course it was impossible to hold the abrasive under such conditions.

Clean wheels set up with the Alundum abrasive gave very satisfactory results and held their cut for a satisfactory length of time.

An Efficient Piston Pin Arbor

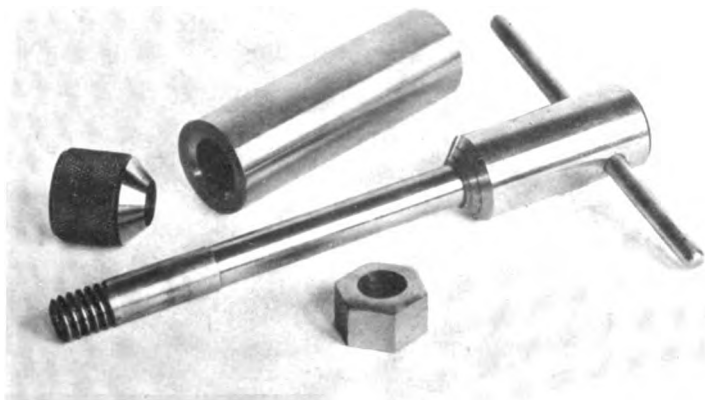
By C. H. HILL

In order to utilize the productive capacity of grinding machinery it is necessary that convenient devices be provided for holding the work. An efficient piston-pin arbor is shown in the accompanying illustration. Both the body of the arbor and the knurled collar are hardened. The forty-five degree conical surface of the collar is ground in place on the arbor. The collar is afterward pressed off the shoulder and

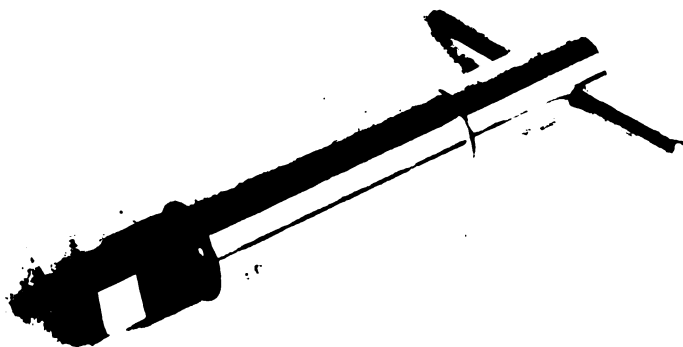
a slight clearance is then ground to permit free movement of the collar.

Note the large pitch of the threads. The nut is lapped onto the threads so that it runs with perfect freedom. The operator's bench should be provided with a metal plate having a hexagonal hole which will serve as a wrench to tighten and loosen the nut.

With two such arbors production of 60 to 90 piston pins per hour may easily be secured.



The above illustration shows the piston pin and arbor. Below is the piston pin assembled on the arbor. The drill rod inserted in the head of the arbor serves both as a driver in grinding and a wrench handle in loosening or tightening the nut





Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Issues

- The Magnetic Chuck, Its Design and Various Uses. Canadian Machinery, April 22, 1920, page 394. An account of the various uses of this style of chuck in the manufacturing plant. A few paragraphs describe its use in various grinding operations. .
- Machining the Gas Engine for a Lighting Unit. American Machinist, May 6, 1920, page 995. The finish grinding of the pistons is illustrated.
- Using Portable Electric Tools. Iron Trade Review, May 6, 1920, page 1333. A few general remarks are made in regard to motors for grinding work.
- Manufacturing Chilled Iron Car Wheels. Foundry, May 15, 1920, page 389. This article deals chiefly with the different types of chillers and the methods of annealing, but it contains an excellent illustration of the grinding operation.
- Comparative Methods of Machining Automobile Engine Connecting Rods. American Machinist, May 13, 1920, page 1023. A series of five articles describing the methods used in the following shops: Packard, Cadillac, Peerless, Chandler, and Franklin. The various grinding operations are illustrated.
- Comparative Test upon High-Speed Steels. Chemical and Metallurgical Engineering, May 19, 1920.
- Fixture for Planing Grinding Machine Columns. American Machinist, May 20, 1920, page 1078.
- Grinders for Dressing Off Gas and Arc Welds. Automotive Industries, May 20, 1920, page 1149.
- Grinding Milling Cutters in Place. American Machinist, May 27, 1920, page 1144.
- Grinding Lathe and Planer Tools. Machinery, June, 1920, page 917.
- Chuck for Internal Grinding. Machinery, June, 1920, page 932.
- Machining Automobile Steering Knuckles. Machinery, June, 1920, page 911. A discussion of some interesting grinding work.
- Machining Packard Connecting Rods. Machinery, June, 1920, page 953. Grinding work.
- Fixture for Grinding Back-Rests. Machinery, June, 1920, page 977.
- H. E. Harris Hob Grinder. Machinery, June, 1920, page 991. A detailed description of a new grinding machine built by the H. E. Harris Engineering Co., Bridgeport, Conn.
- Machining Aluminum Pistons. American Machinist, June 3, 1920, page 1175. The most approved methods of machining aluminum pistons are described in this article by the master mechanic of the Lynite Laboratories in Cleveland. He makes the statement that pistons can be finished more satisfactorily on a grinding machine than on a lathe and recommends a 40 J or K Crystolon wheel for the finishing operation.
- Diamond Tools for Truing Abrasive Wheels. American Machinist, June 3, 1920, page 1219. Description of diamond-pointed tools marketed by the Tungsten Tool Co., Inc., 110-114 West 42nd Street, New York, N. Y.
- Production of Lathe and Planer Tools. Railway Mechanical Engineer, June, 1920, page 384. The object of this article is to show that grinding may be substituted for hand forging in the manufacture of lathe and planer tools.

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What the Grinding Wheel is Doing For the Phonograph

Sidelights on Grinding Achievements of Thomas A. Edison, Inc., in the Construction of the Edison Phonograph

Grinding as a practice among the peoples of the earth is as old as the civilization erected by the countless generations which have inhabited it. It is true that the rubbing process was at the first very primitive, but it is also true that, however crude the method, the process was fundamental to life.

By rubbing and striking two stones together, primitive man drew fire, the element which induced him to feats of creation. Later by rubbing one rough stone against another he produced a point—his first plough point. Years of practice developed a nicety and he advanced from the crude farm implement to a more intricate and efficient means for scratching and digging into the earth. Then when warfare faced him as a problem, he brought to the fore his knowledge of rubbing or grinding with nature's grindstone, shaping for himself weapons; and on his skill in the use of his crude tools depended largely his chances for life and contribution to the upbuild of the rudi-

ments of mechanics.

It is a strange truth that as man has developed to a constantly higher state of civilization, he has fought to make his work permanent. Cultures have been born and have died with a people, but as man's mechanical skill developed, his faculty for maintaining the work of his mind and emotion through the work of his hands has steadily increased. Culture has been maintained for posterity in proportion as science has developed to perpetuate it.

Therefore, it is after all not such a far cry from the Norton grinding wheel and Norton grinding methods to the Edison products—the phonograph and its business co-partner, the Ediphone—for without the delicacy of this machining process on the 200 parts which compose the more intricate instrument for reproducing the beauty of sound, the exactness of the reproduction would be practically impossible. Moreover, it would not be possible to produce this modern sound

device in the large numbers demanded by the public were it not for the speed and economy with which grinding can turn out the finished, component parts. Precision grinding plays an important part in the making of every one of the parts comprising the mechanism, horn, reproducer, and the muting device.

The illustrations give part of the grinding story in connection with the manufacture of this modern invention. Figure 1 shows the first few operations performed on the disc top plates—the snagging of the ends with a Crystolon 24-inch, 3-inch face wheel, grain 24 grade R. The wheel revolves at a surface speed of 5,300 feet a minute and the production is at the rate of 52 pieces per man every hour. On the second operation on disc top plates—the “cleaning up” of the top—a Crystolon wheel, 12 inches in diameter and 2-inch face, grain 60 grade S, is used and is given a surface speed of 5,000 feet a minute. A fine-grain wheel is necessary on this operation to secure a suitable surface for japanning after one buffing operation.

Figure 2 shows the first polishing operation on the reproducer horn necks which are made of sheet brass. A 10-inch diameter, 2¼-inch face, rag wheel is used, coated with No. 90 Alundum grain. The wheel is revolved at 2,000 r. p. m., corresponding to a surface speed of 5,200 feet a minute. The production on this work is at the rate of 15 or 16 an hour for each operator.

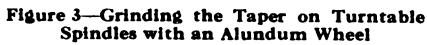
An operation of particular interest is the grinding of the worm, a very important part of the phonograph. An Alundum wheel, grain 60, grade N, 12 inches in diameter, 1-inch face, has been found by the Thomas A. Edison, Incorporated, to



Figure 1 — Snagging the Ends of Disc Top Plates with a Crystolon Wheel



Figure 2—Polishing Reproducer Horns, Using Rag Wheel Coated with Alundum Grain



The surface of the governor disc plate must be absolutely flat. After the third

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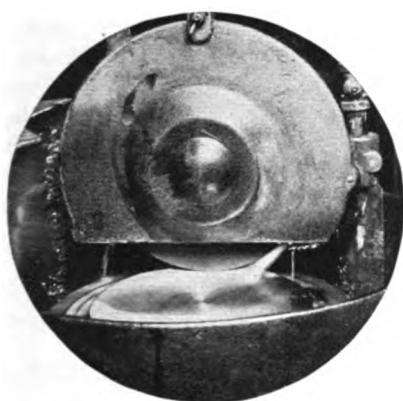


Figure 5 — Rotary Surface Grinding on a Circular Surface Plate with an Alundum Wheel

grinding operation the disc is sent to the lathe department where the face is lapped with No. 65-F Alundum grain and olive oil.

Figure 5 shows a close-up of a rotary surface grinding operation on a circular surface plate of forged carbon steel. This plate is 10 inches in diameter and must be finished perfectly straight, the flatness tolerance being .001 inch. The wheel used on this operation is an Alundum, grain 60, grade K, 12-inch diameter, and 1-inch face, which is revolved at a surface speed of 6,300 feet a minute. These plates come from the lathe faced and the vertical speed is by hand—about .0005 inch every second or third stroke. Both sides of the plate are finish ground with about .003 inch removed from each surface. The work speed is 154 r. p. m. In this work extreme care is taken not to spoil the edge of the plate. The production averages two an hour, the wheel being trued once during that period of grinding. Figure 6 illustrates another polishing operation, the polishing of re-producer cups with No. 90 Alundum grain.

To the uninitiate the grinding wheel and the phonograph seem hardly related; yet

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without the homely medium of the abrasive wheel and the application of scientific grinding principles which are constantly undergoing change as the science of grinding advances, the progress of the phonograph would suffer a parallel quiescence. The point of greatest importance in the latest type of the Edison phonograph is the complete suppression of noise and foreign sound. Silence in the mechanism depends of course upon accuracy, and this accuracy is attained through the most modern methods of precision grinding.

In the recording, then, and reproducing of the transient talent of a generation in the cultivation of which enter a skill and an art, the Norton grinding wheel and Norton grinding service may be said to play a humble, but very necessary part behind the scenes, in giving to succeeding generations the solo work of any great musical artist.

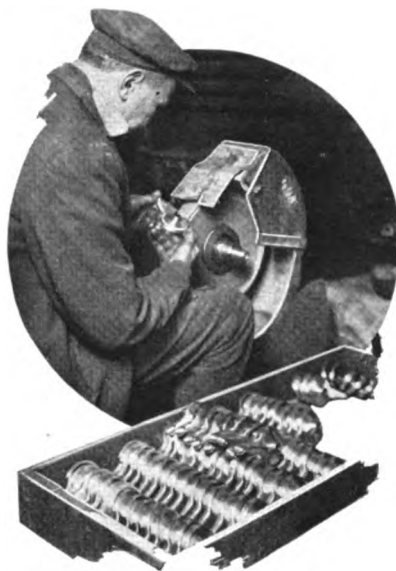


Figure 6 — Polishing Reproducer Cups with Alundum Grain



Alundum Grain in the Manufacture of Stove Parts

Alundum Grain for Polishing Proves Its Excellence on This Class of Hard Work

By W. F. BREFSCHNEIDER AND W. F. FORD

Among the many fields in which Alundum grain for polishing has proved its superiority, its use in polishing stove parts is practically unquestioned from the standpoint of work accomplished, economy in saving the operator's time, saving of set-up time, and good practical finish.

A number of operations enter into the manufacture of stove parts before the completed stove is ready for market—such as molding, mounting, polishing, plating, and buffing.

The castings are first molded in the foundry and are made either of cast iron, gray iron, or malleable iron. After molding they are prepared for the polishing operation, and this preliminary treatment may be tumbling or pickling, the object being to remove any sand or scale which may be left on the molded piece when removed from the cast.

In the case of the gates there is a preliminary grinding operation, particularly when the castings are of malleable iron. On this work Alundum vitrified wheels, grain 20, grade Q, are used. Within the last few years the polishing of the gates has been followed by heat treating. The order of operations, however, for the other parts, such as doors, handles, shelves, and rails, is polishing, plating, and buffing.

In the second illustration is shown an automatic top polishing machine used in The Charter Oak Stove and Range Company, St. Louis, Mo. The tops are

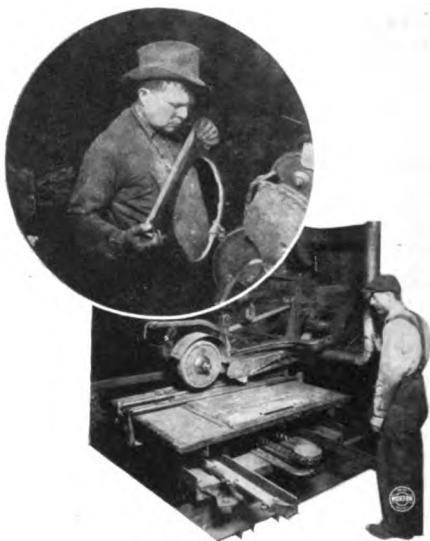


Figure 1 (above) — Roughing Out a Drop Door with Alundum Grain

Figure 2 (below) — Automatic Top Polishing Machine

placed on this machine just as they come from the foundry, the operation varying according to the style of top to be finished. On the preliminary grinding operation a Crystolon wheel, grain 80 grade N, is used after which the top is finished on a hand rough polishing machine with 6670 Alundum. This is in case of low spots which are sometimes left where the grinding and polishing on the automatic will



not reach. After they have been roughed out by hand, they are placed on the automatic polishing machine again for the final finish with 6670 TJ Alundum.

In the first illustration is shown the roughing out operation on a drop door—6670 TJ Alundum being used. Figure 3 shows dry-fining with 66150 Alundum on a stove leg; and in figure 4 is illustrated the greasing out of another oven door with 66180 Alundum.

Stove polishing as a general thing is hard work; in fact, it is one of the hardest classes of work in the polishing line. For this reason, the very best grade of glue and the highest class of abrasive that can be bought are in reality the least expensive.

The abrasive action of polishing grain depends upon the amount of crystalline alumina present in the abrasive. Alundum grain is practically 94% crystalline alumina. Turkish emery, on the other hand, contains at the most from 60 to 65%. The artificial abrasive because of its high corundum content and the lack of porosity of the cutting grains gives faster and freer action with a consequent increase in production. Examples of the saving of the operator's time in actual polishing of a given number of pieces and in the time required to set up the wheels with artificial abrasive as compared with the natural abrasive are quoted in detail on page 9 in Notes from the Files of the Sales Engineering Department.

The testimonial of a polisher in one of the large stove shops in St. Louis, who has had 20 years' experience, during which he has worked on stoves, has considerable value for the individual or con-



Figure 3—Dry-fining Operation on a Stove Leg with Alundum Grain

cern for whom polishing has great interest. "Working with emery and other abrasives," he said, "I have noticed that it is necessary to bear much harder on the wheels to make them cut. The cutting action is not as free as with Alundum; hence, it is harder on a polisher. A wheel covered with Alundum will cut just as long as there is any on the wheel. With emery and other abrasives the wheel will glaze and there will be more abrasive on the wheels when they are done cutting. For instance, a soft wheel will become extremely hard after it has been covered several times with emery, unless it is buffed off frequently. With Alundum there is less buffing to do, wheels last longer, less time is required for covering them, with a saving of wheels, glue, abrasive, and labor."

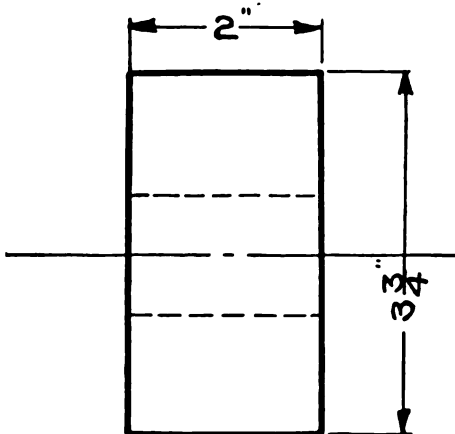


Figure 4—Greasing
Out an Oven Door
with Alundum Grain

Every concern has different makes of wheels in use for different operations. The wheels for common use are: for roughing, discs of canvas glued together, sections of muslin buffs glued together, and sub-felt; for dry-finishing, practically the same wheels as for roughing; for finishing, in some cases, the wheels listed, and often felt, sheepskin, and bullneck.

In general the numbers of Alundum grain used on various stove polishing operations are: for roughing stove tops—24, 60, 70, 80; for roughing other parts—46, 60, 70, 80; for dry-finishing—90, 100, 120; for finishing—120, 150, 180.

Sixty-six Motor Rotors an Hour on a Norton 6" x 32", Type A, Machine



PART—Motor rotors

PREVIOUS OPERATIONS—
Stamped

MATERIAL—Electrical Steel

LIMITS—.002"

STOCK REMOVED—.015 to .020

MACHINE—6" x 32", Type A

WHEEL—14 x 2 x 5 Alundum
Grain 46 Grade N

PRODUCTION—66 per hour

RECORD MADE—Sept. 16, 1919,
at East Springfield, Mass.



Notes from the Files of the Sales Engineering Department

Alundum Versus Emery for Polishing

Below are a few interesting figures showing the comparative results obtained in tests of Alundum grain against emery for polishing.

Turntables

These are made of cold-rolled steel, blanked and bent in a punch press into cover-shaped pieces 12 inches in diameter. They are polished on the side and edge to remove the punch marks produced during the bending.

Five wheels covered with Alundum grain, size No. 100, polished 425 pieces, 85 pieces per wheel. Five wheels set up with the same size emery produced only 250 pieces, or an average of 50 pieces per wheel.

Crank Handles

These handles are made of soft-steel rods about 12 inches long by 5-16 inch diameter and are tapered on one end similar to a drum stick. They are polished all over. Formerly, No. 100 emery was used for roughing and No. 150 for the finish oiling.

Four wheels covered with No. 100 emery produced 650 pieces, while two wheels covered with No. 120 Alundum produced the same number of pieces and gave a satisfactory final finish.

Automobile Parts

These are miscellaneous steel pieces. It required six wheels coated with Turkish emery for one day's work. The same job was accomplished with three Alundum coated wheels. The grain used was Alundum No. 6660.

Auto Radiator Shells

These are steel-iron shells and are polished all over immediately after pressing. On "Hudson" shells it required only one wheel coated with No. 60 Alundum to average 43 shells. With the same size emery coated wheels only 9 shells were averaged in the same time.

On "490" shells one wheel with No. 60 Alundum averaged 53, and the same size wheel coated with emery averaged only 12.

Pliers

These are steel forgings. In this particular test the face and nose were polished. Leather-covered block wheels were used. To polish 500 pliers only one wheel coated with No. 70 Alundum was required; but to do the same work with emery required three wheels of the same size.



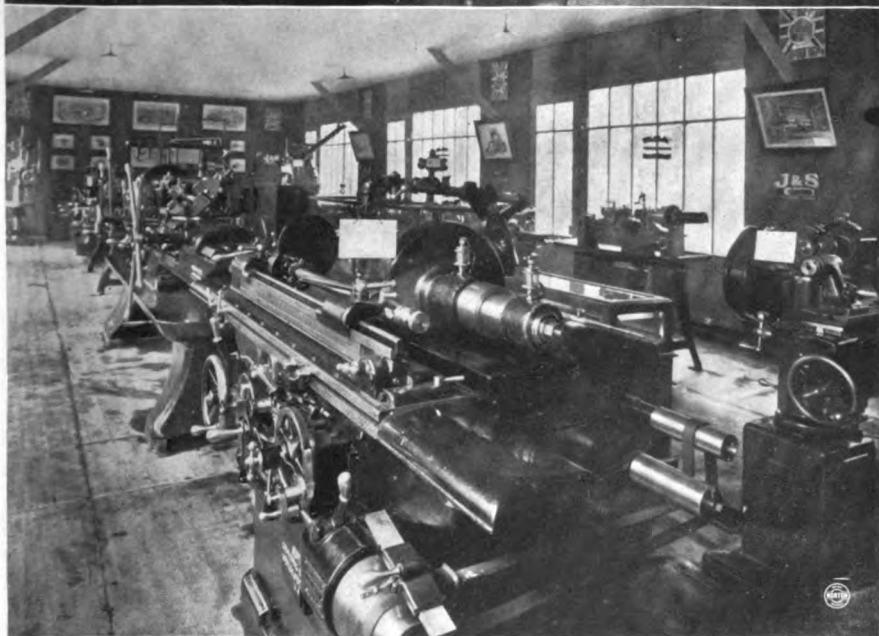
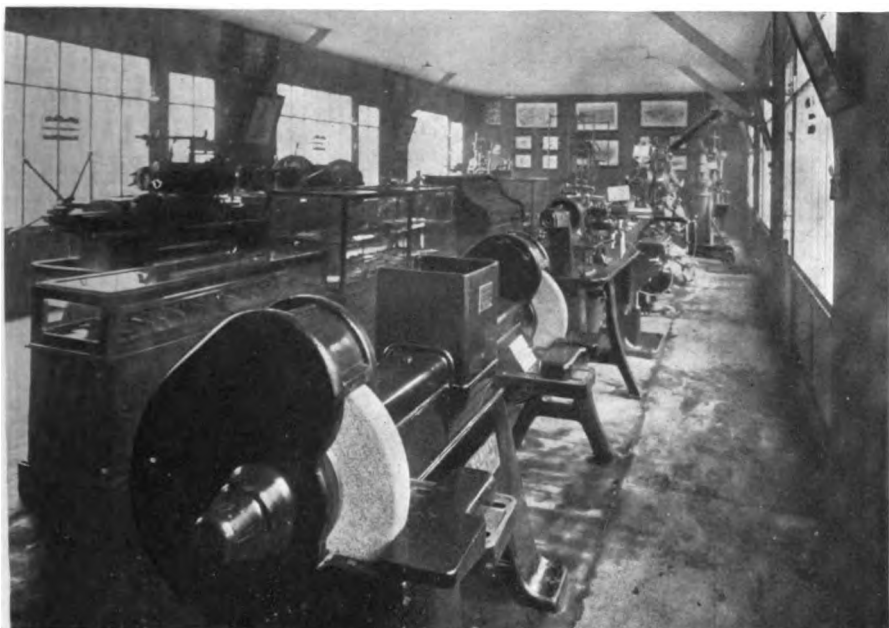
Showing an Exhibit of Norton Wheels at the Brussels Fair

Strong Revival of Interest in Trade Matters in Belgium

Further exhibition of the staunch spirit of Belgium is being shown by their quick rebound from the discouragements of war to a program of progressive upbuild and reorganization.

In the reconstruction of wasted areas which is progressing at an amazing rate there is naturally a corresponding revival of interest in reconstructive machinery and everything pertaining to the field of mechanics. Belgium with the rest of war-ridden Europe has come back to business and daily is becoming more commercially active.

The pictures shown give some idea of the extent of a recent exhibit at the Brussels Fair held by the Henri Benedictus Company, agent for Norton machines and wheels in Belgium. The illustration above gives an idea of the wheel exhibit. The man standing is A. Falgoneer, Norton wheel representative with Henri Benedictus. The illustrations on the opposite page give a splendid idea of the showing of Norton floor stands and the Norton grinding machines. This agent tells of the great interest of his country in trade matters.



[August, 1920]

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Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Issues

- Making Piston-Rings.** American Machinist, June 17, 1920, page 1279. Grinding plays an important part in the manufacture of piston-rings. The various operations are described at some length in this article.
- Grinding the Inner Flanges of Spools.** American Machinist, June 17, 1920, page 1309. The Oakley Machine Tool Co., Cincinnati, Ohio, has built a special form of their standard toolroom grinding machine for this operation.
- Sanford Centerless Grinding Machine.** American Machinist, June 17, 1920, page 1322. This machine is manufactured by the F. C. Sanford Mfg. Co., Bridgeport, Conn.
- Twist Drill and Milling Cutter Grinder.** American Machinist, European edition, June 19, 1920, page 58E. Manufactured by S. Holmes & Co., Bradford.
- A Few Splittorf Details.** American Machinist, July 8, 1920, page 76. A description of the grinding operations on the Splittorf aircraft magneto, built by the Splittorf Electrical Co., Newark, N. J. Several operations occur during the manufacture of the magnet which is said to be the most difficult part of the magneto to manufacture.
- Universal Grinder and Button Die Grinding Attachment.** Iron Age, July 8, 1920, page 70. This machine is manufactured by the Lafayette Tool & Equipment Co., Lafayette, Ind.
- Heavy Duty Grinding and Buffing Machines.** Iron Age, July 8, 1920, page 82. A new line of 1-hp. electric grinding and buffing machines of heavier types than have been heretofore made by this company has been brought out by the Van Dorn Electric Tool Co., Cleveland, Ohio.
- Band Saw Grinder.** Wood-worker, June, 1920, page 41. The writer of this article explains how a band saw should be put on the grinding machine.
- Grinding Circular-Formed Cutter Teeth.** American Machinist, June 24, 1920, page 1357.
- Hobart Motor-Driven Grinder.** Machinery, July, 1920, page 1091. Description of a recent product of the Hobart Bros. Co., Troy, Ohio.
- Cylinder Boring and Grinding Machine.** Machinery, July 1920, page 1092. Description of a grinding machine made by the Sunderland Machine Shops, 21st and Pacific Streets, Omaha, Neb.
- Automatic Hob Grinding Machine with Unit Motor Drive.** Iron Age, July 8, 1920, page 72. In answer to a demand for a motor-driven type of automatic hob grinding machine, the H. E. Harris Engineering Co., Bridgeport, Conn., has developed a machine known as the No. 815M described and illustrated in this article.
- Ball Bearing Twist Drill Grinder.** American Machinist, European edition, June 26, 1920, page 64E. The firm of H. F. Atkins, Ltd., Old Fletton, Peterborough, are manufacturing twist drill grinders of the type here illustrated.
- Grinding Wheels, Their Manufacture, Uses in Industry, and Factors Affecting Their Selection.** Proceedings of the Engineers' Society of Western Pennsylvania, April, 1920, page 205.
- Grinding Attachment for a Milling Machine.** American Machinist, July 15, 1920, page 114. This attachment is designed for accurate toolroom work on gages. A complete set of drawings for its construction are given.
- Device for Centering Cylinders Preparatory to Grinding.** American Machinist, July 15, 1920, page 131.

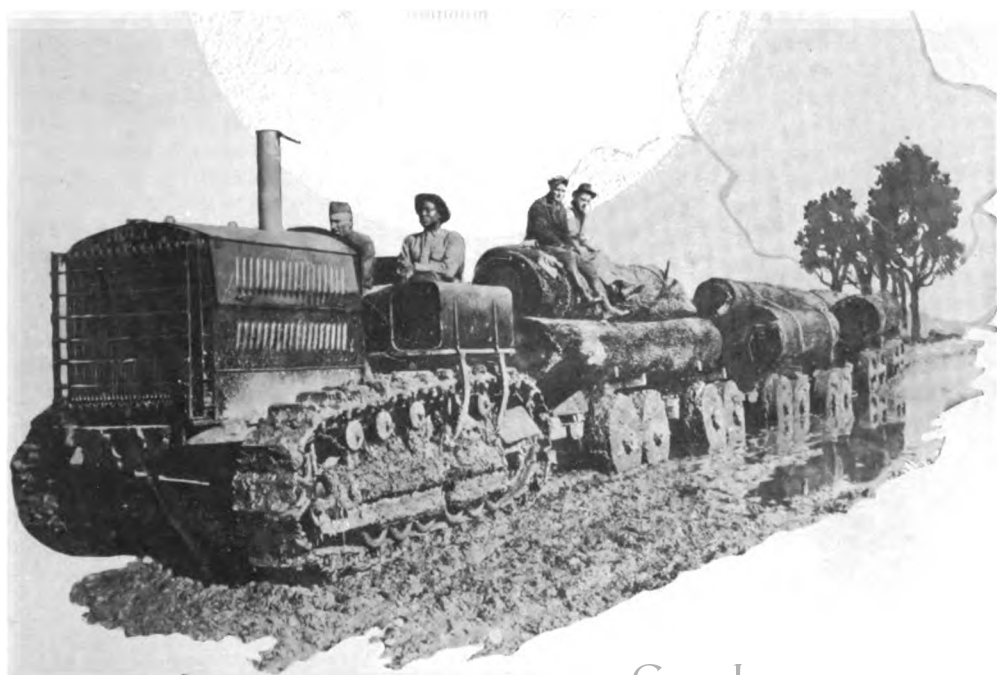
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GRITS and GRINDS

SEPTEMBER, 1920





Grits and Grinds

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Grinding in the Construction of the Holt "Caterpillar" Tractor

The close relationship between grinding and many widely varying industries is only realized when an inspection of manufacturing methods in use by such industries is made. Investigating the vast number of operations performed in plants where the precision job predominates, we find that grinding has gradually grown in importance until it now in many cases overshadows all other work.

Excellent examples of the latest and best in grinding are to be seen in the two large plants of the Holt Manufacturing Company, at Stockton, California, and Peoria, Illinois, respectively. Here the machine which makes cross-country transportation and a vast amount of other work possible, is built on a production basis. Who is there to-day who has passed his first decade and has not heard of that weirdly wonderful machine the "Caterpillar" Tractor?

The Holt "Caterpillar" with its close limit parts—its finely finished mechanisms—depends upon the most modern methods of grinding for its power, its endurance and its marvellous versatility. Grinding therefore made possible, even though indirectly, the ascent of Pike's Peak for the first time by a mechanically propelled vehicle; made possible the

negotiation of natural obstructions, the hauling of heavy loads over rough or soft ground; brought into the realm of realization, agricultural and other operations on a scale heretofore regarded as impossible. Grinding did these things, for without grinding, the tractor which performs them would have been impossible.

Grinding first enters into the manufacture of "Caterpillar" Tractors in the snagging department. Here the fins, burrs, and rough edges are removed from a wide range of castings and forgings.

Our first illustration shows the snagging of the crankshaft for the 5-ton "Caterpillar" Tractor, an air motor driving the wheel. For this work Alundum vitrified wheels, grain 20, grade R, 8" diameter, 1" face, are employed.

The second picture illustrates the snagging of a truck roller. An air motor is also used in this case, and a 30-S Crystolon vitrified wheel, 8" diameter, $\frac{3}{4}$ " face, is employed.

Alundum vitrified wheels, 14-S, 24" diameter, 3" face, are preferred for snagging steel castings and drop-forgings on floor grinding machines, and Crystolon vitrified wheels, 16-S, are found best for snagging cast-iron parts.



Figure 2—Snagging a Truck Roller with a Crystolon Wheel, Driven by an Air Motor

For grinding milling cutters on the wet tool grinder, Alundum vitrified wheels, 3846-K of 10" diameter and 1/2" face, are employed.

For cut-off work the choice is 60 grade 4 Alundum elastic.

The third illustration is merely representative of an extremely varied line of broach grinding, and illustrates the grinding of a broach for cutting splines in the inner disc hub of the master clutch.

Comparing the engines of to-day with those of but a decade or two ago we are struck with the great difference in the ratio between weight and power. The modern motor, though it develops enormous power, has very little weight.



Figure 3—A Wide Range of Broach Grinding is always in Process. This Broach is for Cutting Splines in the Inner Disc Hub of the Master Clutch

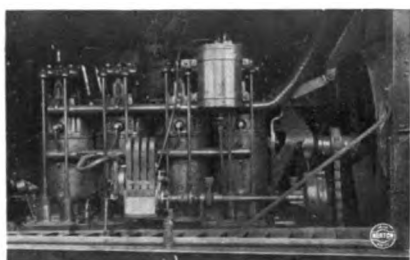


Figure 4—"Under the Hood." The Power Plant of the 10-ton "Caterpillar" Tractor



Figure 5—Cast-Iron Gear Cases are Surface Ground in Large Quantities. The Operation Illustrated Here is One in Which a Crystolon Wheel is Employed

This has been caused by greater precision, permitting higher speeds and less leakage of power.

Since this precision is attributable to modern grinding it is safe to say that on grinding depends practically every modern mechanical industry. Not only so, but a vast majority of ancient industries have been brought up to date by the possibilities placed at our disposal by precision grinding.

The Roman legions built roads which the automobile runs on to-day, but took centuries to do it. If the Cæsars could see a week's work in road grading by a modern tractor and road grader they would open their eyes.

The horse and plow are more up-to-date than the spade, but neither is a patch on the "Caterpillar" Tractor and the equipment it hauls.

There's a big difference between logging by horse or mule—handling one log at a time—and walking down a swampy trail with 3,500 ft. of hardwood as does the "Caterpillar" Tractor.

Only light weight and high power made these things possible. Thus we can directly trace the results to the attainments of modern grinding.

In the Holt plant precision grinding is performed on numerous widely varying parts. Many of such parts have been hardened, hence can be finished in no other way.

An example of surface grinding is shown in figure 5, where a Crystolon wheel is being used on a gear case cover. The wheel, 18" x 5" x 1½" rim, revolves at 870 R.P.M., the work at 29 R. P.M. The feed is .003" per revolution of work.

It is interesting to note that much of this work now done with grinding wheels was formerly handled by milling machines, the change being made after the former had demonstrated its superiority by turning out many times the work.



Figure 6—An Internal Grinding Operation on a 21-Tooth Spur Gear Performed After Hardening

An instance of this is to be found in the facing of connecting rods by grinding, the production of which was actually increased *five-fold* by milling with a 3820-J Alundum wheel. This seems to bring out the conclusion that it is never safe to decide upon any matter of machining without thoroughly investigating the great possibilities of grinding. In another respect, too, grinding is far preferable to machining, for simpler fixtures are invariably required, and sometimes even these can be dispensed with.

The internal grinding is to a large extent on hardened gears, the favorite

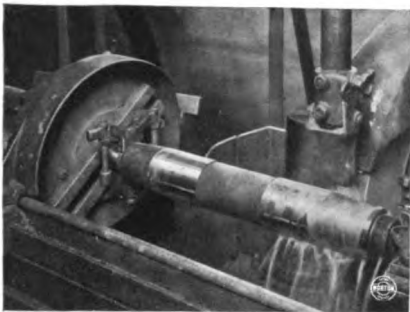


Figure 8—Intermediate Shafts of Nickel Steel are Ground on a Norton 14" x 72" Machine with an Alundum Wheel

wheels being Alundum vitrified, 3846-K and 3860-L.

In the internal grinding operation on a 21-tooth spur gear shown in figure 6 the hole is bored before hardening to 3.862" within limits of .001". After hardening to a scleroscope reading between 75 and 85 this hole is ground to 3.875" with a plus limit of .001".

Figure 7 shows cylinders for 10-ton tractor engines. These cylinders are bored to 6.483"—6.488" diameter for a length of 11 13/16". Rough grinding enlarges the diameter .017" and the

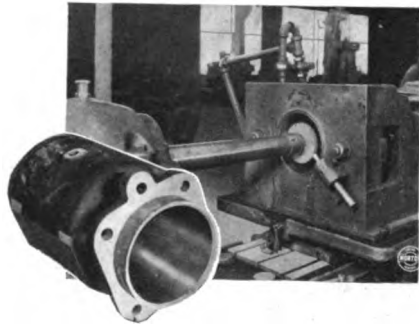


Figure 7—Internal Grinding Operation on a Cylinder for a 10-ton Tractor. A Crystolon Wheel is Used

finish grinding takes out .001" more. Limits of the finished cylinder bores are 6.5025"—6.5045". The wheel found best is a 36-J Crystolon vitrified 5 1/2" diameter by 1/2" face.

Fairer trial of equipment none could ask than the fierce tests of modern war. The World War was a war of precision—the closest limits won the day. It was the mechanical developments which went before—the methods instituted—which brought it to a successful conclusion.

It was soon found that the most advanced types of grinding wheels and general grinding equipment were fundamentals not only in the fabrication

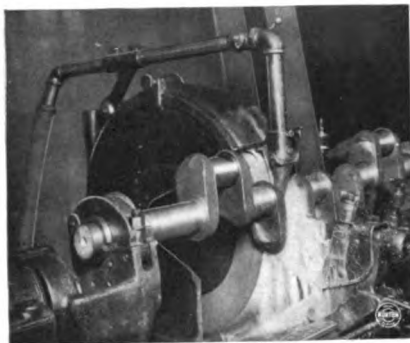


Figure 9—Modern Method of Grinding Crankshafts of Drop Forged Steel, Chrome Nickel, 60 Point Carbon

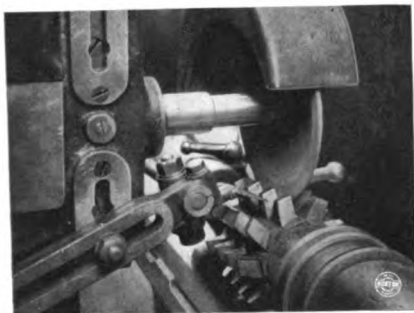


Figure 10—Grinding the Hob for Transmission Gear



Figure 11—Engines Must be Dependable. This Shows the Testing of the Motors for the 5-ton "Caterpillar" Tractor

of most of the munitions of war, but in filling nearly every need of the vast undertaking. Not only did delicate instruments demand precision, not only had guns to be made with the greatest accuracy, but the need for close limits extended into almost everything which became a part of army life.

In the Army Transport Corps accuracy was of paramount importance. Particularly in hauling equipment was precision prescribed, for it permitted that which in no other war had been attained with such perfection—lightness, power and consequent mobility. Compare, for example, the "Caterpillar" Tractor, to the parts of which modern grinding methods have given an assured accuracy—compare the efficiency of this machine—its ability to go practically everywhere—to, say, the steam sapper used by the British in South Africa.

Most of the basic needs of the nation are dependent upon transportation and power, and to describe the many phases of industrial life into which the "Caterpillar" Tractor enters would take far more space than we have here at our disposal.

On the rough ground incidental to oil fields where rail communication would take years to establish, the pioneer work of cross-country haulage is delegated to the "Caterpillar" Tractor.

The demand for increased food production from our industrial centers brought a call from agricultural sections for labor-saving machinery. The "Caterpillar" Tractor pulls plows, harrows, seeders, harvesters, furnishes power for pumping water, filling silos, for operating threshing machines; it clears sage brush, uproots trees and stumps, and does a vast deal of other useful work.

In presenting these grinding operations—just a fraction of the full total at this big Holt plant—some conception of the increasing use of the grinding method of “machining” may be gained.



Notes from the Files of the Sales Engineering Department

Alundum as a Polishing Abrasive

The characteristics of Alundum abrasive, the Norton electrically fused alumina, make it an excellent grain for polishing. A short discussion of these characteristics and their comparison with those of emery may make clear just why Alundum is being found to be the best polishing abrasive on the market.

Abrasive Action

The abrasive action of any polishing grain is dependent upon the amount of crystalline alumina present in the grain. Alundum grain is practically 92% crystalline alumina. On the other hand the best grades of Turkish emery contain at most only 60 to 65% Corundum which is the form in which crystalline alumina occurs in emery. Emery mined in America is by no means as pure as Turkish emery, containing as low as 10% Corundum.

Alundum Versus Emery

A large percentage of the several impurities in emery is magnetic iron oxide. This is actually mixed in the grains of emery making them porous. Alundum grains are solid tough crystals. Also since emery is a natural mineral, its quality varies a great deal from one mine to another and even from one vein to another in the same mine. Alundum abrasive, an artificial product, is held to a uniform formula and because of close control during manufacture the

crystal structure and percentage of alumina present are held within very close limits.

Effect on Polishing Ability

These properties, of course, have their effect on the use of abrasives on set-up polishing wheels. Emery, because of its low Corundum content and porosity of the grains, is not strong enough to remove a large chip, but breaks off much quicker than electrically fused alumina. Because of this, wheels set up with emery do not give the production that can be obtained with Alundum abrasive.

Glue and Its Preparation

Maximum production can be obtained with Alundum grain, only by the use of good glue and by properly applying the glue and grain to the wheel. With a little care exercised along these lines the production per wheel has been increased 100% to 500%. With the use of weak glue which has had the "life" cooked out a lot of abrasive particles are thrown off by the wheel before they have done their work.

Good glue, either flake or powdered, should be used. Most glue manufacturers make a glue especially for setting up abrasive polishing wheels.

Ground glue should be soaked in cold water for about two hours; flake and sheet glue over night. A common mixture is one pound of glue mixed with one pound



of water. This formula can be changed to make a thicker or thinner glue to meet local conditions. Cooking is best done in a pot surrounded by a hot water bath, the temperature never being allowed to go over 160° Fahrenheit. Glue cookers can be obtained having automatic temperature controls. They are very satisfactory and where considerable polishing is done, their use is recommended.

Cook the glue from one and one-half to two hours at 150° to 160°. It can then be cooled to between 130° and 140° and used at this temperature. Only enough glue for use during the day should be mixed, as glue that has been allowed to stand hot for 10 hours, then cooled over night and reheated in the morning is of no value. The glue remaining in the pot each night should be thrown away and the pot thoroughly washed before putting the glue to soak for the next day.

Wheels are best set up in a room assigned for this purpose. Glue is applied to the wheel using a brush. The wheel is then rolled in the Alundum contained in a long box.

Preparation of Abrasive

The Alundum grain should be heated so that it will not chill the glue when applied. Chilled glue loses some of its holding power. A very convenient way of heating the abrasive is to have steam-pipes run through the bottom of the box. Do not allow cold air draughts to blow through the set-up room.

Drying Wheels

After the wheels have been set up and the abrasive pounded into the wheel face, hang them up in the drying room for at

[8]

least 12 hours. Good results cannot be obtained by using wheels that have not properly dried. The wheels gum over and cannot be used as long as if they were in proper condition. It is cheaper to have a larger number of wheels. Best results will be obtained if the wheels are allowed to dry for 24 hours.

For different kinds of polishing it is of course necessary to use different types of polishing wheels. These include leather covered wooden, canvas, felt, sewed buffs, muslin and walrus wheels, all having their special fields.

Trials

When ordering grain for trial the safest and best method is to send us a sample of the grain now being used. We can then duplicate the size exactly.

Service

We have available several expert grain demonstrators who are practical polishers. They are available for supervising tests in our customers' own plants and are well qualified to make recommendations to increase the efficiency of polishing departments. We also have a large number of records on file in our Grain department and Sales Engineering department. Refer your polishing problems to us and we shall be glad to have our grain demonstrators investigate conditions.

Alundum grain properly applied to wheels is the best and most economical polishing abrasive yet developed.

[SEPTEMBER, 1920]



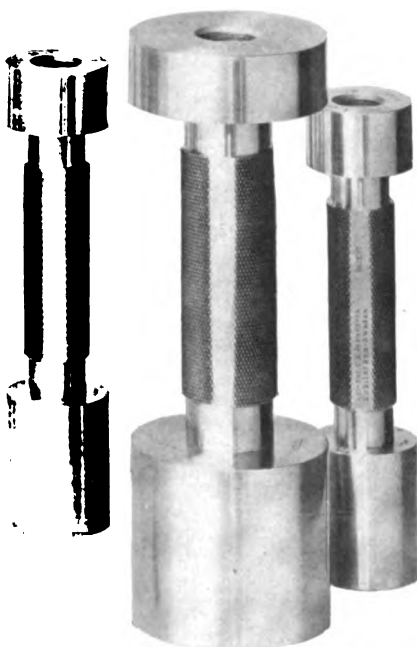
Grinding Operations on Johansson Tolerance Plug Gages

By R. S. COE

Advertising Manager, C. E. Johansson, Inc.

From the manufacturing standpoint, the grinding operations on tolerance plug gages of high accuracy are second in importance only to the operation of the final lapping of the gaging ends. It is most essential that in reducing the diameters to the desired oversize for lapping the grinding at all times be dependably uniform. When the most efficient grade and grain wheel for each operation is decided upon, the operator wants to be certain that in successive lots the action of the wheel marked of the same grade and grain will be, as far as possible, identically the same on all plugs he is to grind. If this can be depended upon a great saving in time will result. After exhaustive tests, Alundum wheels of the specified grain and grade given below have been adopted as the best by C. E. Johansson, Inc., Poughkeepsie, in the manufacture of their tolerance plug gages.

The principal operations in the manufacture of Johansson tolerance plug gages



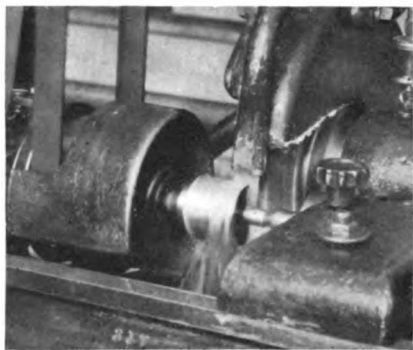
are as follows and in the order named: turning, knurling, and cutting the bodies of both gaging ends in an automatic screw machine; milling flats in the bodies; stamping the bodies of both gaging ends; hardening the members of the gages; rough grinding the "Go" and "No Go" gaging ends; treating and seasoning the steel in the ends; finish grinding the "Go" and "No Go" ends and finally lapping the gaging ends to the specified sizes within a guaranteed accuracy of .00004".

The gages are then assembled, packed, and sent to high precision manufacturing concerns all over the world. The two grinding operations on the gaging ends will be of most interest to the readers of "Grits and Grinds."

As there is comparatively little wear on the "No Go" end of a plug gage it does not have to be as large as the "Go" end in order that its accuracy may have the same length of life. This makes it possible on the rough grinding operation to grind two "No Go" ends at one time as is shown



in the illustration on this page. A Greenfield grinding machine is used on this operation and the most satisfactory wheel has proved to be a $10 \times \frac{3}{4} \times 1$ (or $10 \times 1 \times 1\frac{1}{2}$) Alundum 60 grain L grade. As is the case where work is to be held to a great accuracy, quantity



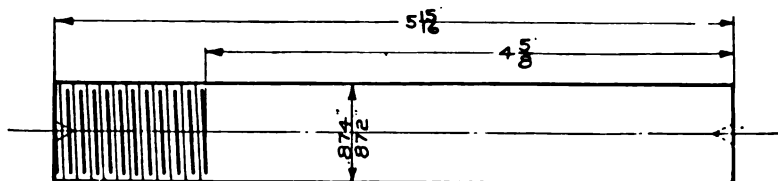
Grinding Two "No Go" Ends at One Time

production figures are not of as great importance as uniform results and finish. Therefore, the time required to produce pieces of certain size varies so much that

any figures that could be given here would have but little significance. The "Go" ends of each plug are rough ground singly—the same grain and grade regular Alundum wheel of different thicknesses being used.

After the gaging ends have been treated and seasoned, before they are sent to the Lapping department, they are finished to various oversizes, depending on the type and diameter of the gage, which are as near the final desired size of the plug as it is practical to go. It can be readily seen that the grinding operation here is a very important one. Not only should the amount of work taken off on each cut be absolutely under control, but the progress of the earlier lapping operations depends to a considerable degree on the "finish" of the gage, left by the grinding. Several grains and grades have been tried on this exacting work as it was thought that a finer wheel of perhaps a 38 combination might give a superior finish. However, here again the 60-L regular Alundum proved to be the best and has been universally adopted.

Sixty of These Shafts per Hour



PART—Shaft—(Rough grind)

MATERIAL—.25 carbon steel, carbonized and hardened

LIMITS— $\pm .001''$

STOCK REMOVED—.025'' to .030''

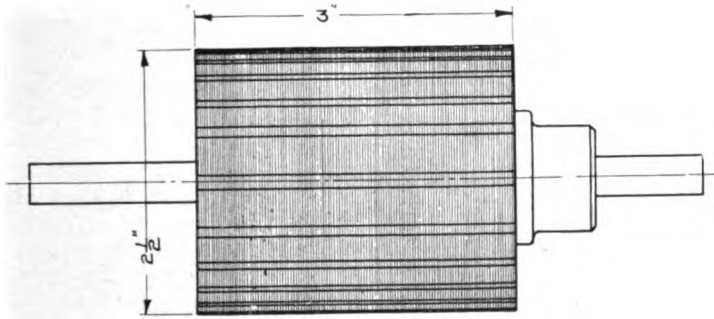
MACHINE—10 x 24 Special Purpose, Type A, Serial No. 7065

WHEEL—20 x $4\frac{1}{2}$ x $12\frac{1}{2}$ Alundum Grain 3836 C Grade M

PRODUCTION—60 per hour

RECORD MADE—Feb. 19, 1920, at Dayton, Ohio

Alundum Wheels for Grinding Armatures



Ground dry

PART—Armatures

WHEEL—14 x 2 x 5" Alundum

MATERIAL—Laminated Steel

Grain 36 Grade J

LIMITS—.002"

PRODUCTION—90 per hour

STOCK REMOVED—.030"

RECORD MADE—April 4, 1920, at
East Springfield, Mass.

400 Ball Race Cups Per Hour

PART—Cup—Ball race

MATERIAL—Steel

LIMITS—±.001"

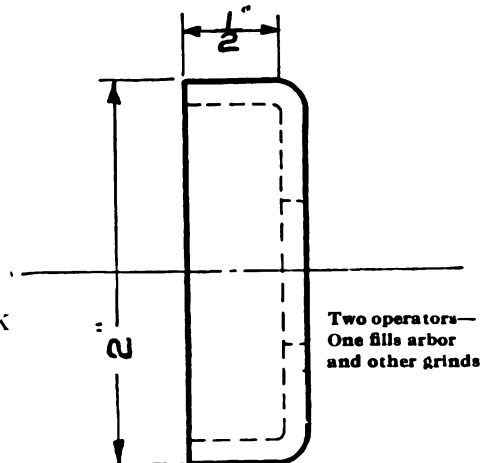
STOCK REMOVED—.025"

MACHINE—10" x 36", Type A

WHEEL—18 x 2 x 5 Alundum
Grain 3860 Grade K

PRODUCTION—400 per hour

RECORD MADE—at Rockford, Ill.





Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Issues

Manufacturing Three-Area Contact Ball Bearings. *Machinery*, August, 1920, page 1107. A detailed description of the manufacturing methods used in the shops of the Federal Bearings Co., Inc., Poughkeepsie, N. Y. Several grinding operations are illustrated and one figure shows a sectional view of the specially designed radial grinding machine used in grinding the race rings.

Making Whitworth Thread Gages. *Machinery*, August, 1920, page 1157. The machine designed for grinding threads by this process was built by Drummond Bros., Ltd., Guilford, Surrey, England, and is shown in one of the illustrations.

Precision Thread Grinder. *Machinery*, August, 1920, page 1170. Designed by H. Wiederhold, of the Diehold Mfg. Co., Brooklyn, N. Y. This article describes the machine in detail and contains an illustration of the grinding wheel housing design in which special provision is made to prevent vibration of the wheel.

Diamond Heavy-Duty Face Grinder. *Machinery*, August, 1920, page 1181. This grinding machine is intended for heavy work ordinarily performed on planers or large millers.

Van Norman Bore Grinder. *Machinery*, August, 1920, page 1183. Very detailed description of a No. 9 bore grinding machine recently placed on the market by the Van Norman Machine Co., Springfield, Mass.

Bryant Chucking Grinder. *Machinery*, August, 1920, page 1190. Brief account of a self-contained grinder brought out by the Bryant Chucking Grinder Co., Springfield, Vt.

Gardner Abrasive Disk. *Machinery*, August, 1920, page 1191. This product which has been called the "G. I. A." (Gardner improved abrasive) disk, has been developed by the Gardner Machine Co., Beloit, Wis., for use on disk grinding machines.

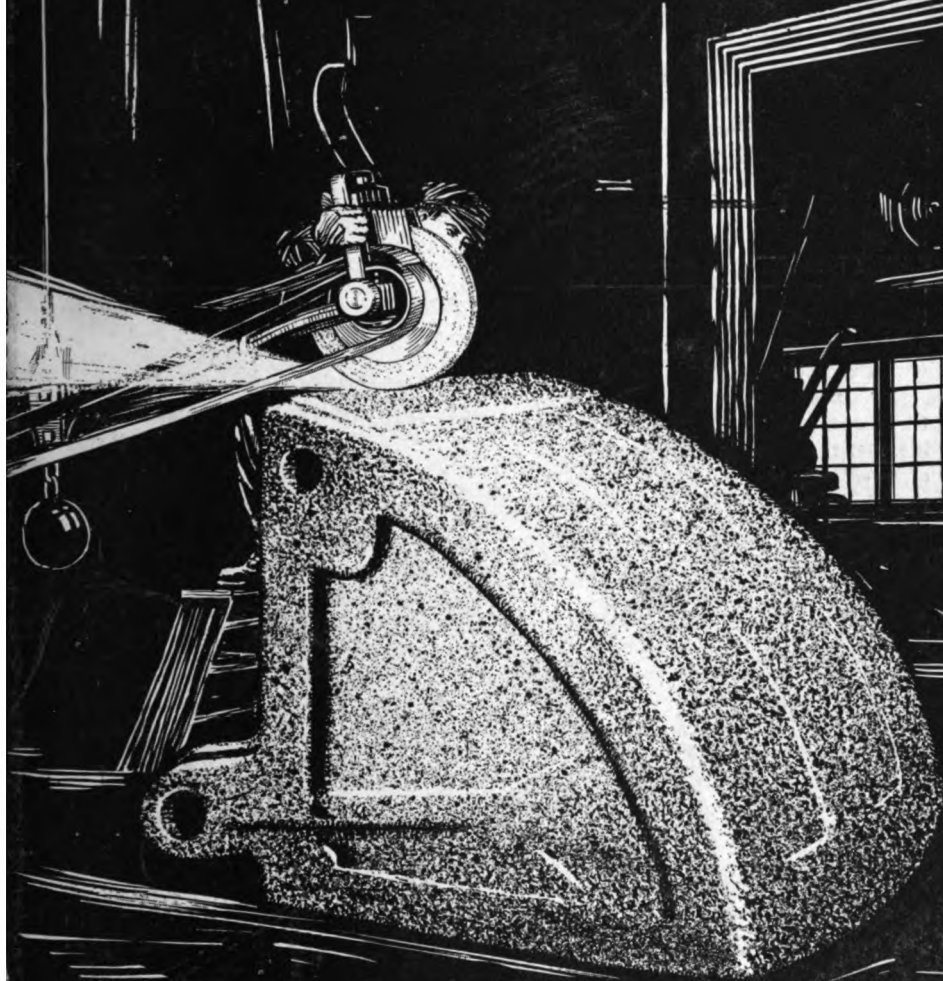
Rickert-Shafer Chaser Grinder. *Machinery*, August, 1920, page 1191. This machine is marketed by the Rickert Shafer Co., 612 W. 12th Street, Erie, Pa.

Surface Grinder. *American Machinist*, European edition, July 10, 1920, page 75 E. Short description of a surface grinder exhibited by Armstrong, Whitworth & Co., Ltd., Openshaw, Manchester, England.

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Cast Iron Foundry Cleaning Room Efficiency

By L. M. KRULL

The grinding wheel plays such an important part in the foundry cleaning room that it is well worth considering how this tool can be used most efficiently. Since labor and overhead are the two important items to observe with an aim towards their reduction per unit of product, it is necessary to follow the process in the foundry from the beginning with this in mind. Consider overhead and labor as the two important cost items in a cast-iron cleaning room, because carbide of silicon wheels which are used for snagging the castings have a comparatively long life, and therefore the wheel cost per unit of product is very small compared with the labor and overhead for the same unit.

Preparation of Casting Prior to Grinding

The amount of grinding to be done on a casting is exactly in proportion to the excess metal left after the gates and fins have been knocked off. A bad practice in making gates in the mold results in excessive grinding. Often it is necessary to have a hammer at the grinding-wheel stand so that these projections can be knocked off. This requires time and time is money. Where it is possible and feasible, the gates should be molded instead of hand cut. In either case the gate should so taper that it will break off

near the casting. Broad thin gates break better than thicker and narrower ones.

Tumbling is the cheapest method of removing the sand from the general run of castings. In addition many fins and gates are knocked off in this operation.

Method of Handling

More important than the above mentioned points to observe is the method of handling the casting. The object here is to keep the wheels of the grinding stand in contact with the castings for as much of the day's time as possible. The time spent in getting a casting to the grinding wheel and properly disposing of it after grinding should be kept at a minimum. This can be brought about by proper arrangement of machines and a good system of trucking. The castings should be arranged in three groups—heavy, medium, and light. Large heavy castings are ground by means of swing-frame machines, or portable grinding machines. These machines should be placed in easy reach of the crane. All castings which can be readily handled—that is, from 1½ to 60 pounds—should be snagged on floor stands. Castings smaller than 1½ pounds are more economically ground on bench stands.

The feeding of the castings to the grinding machines and the removal of the

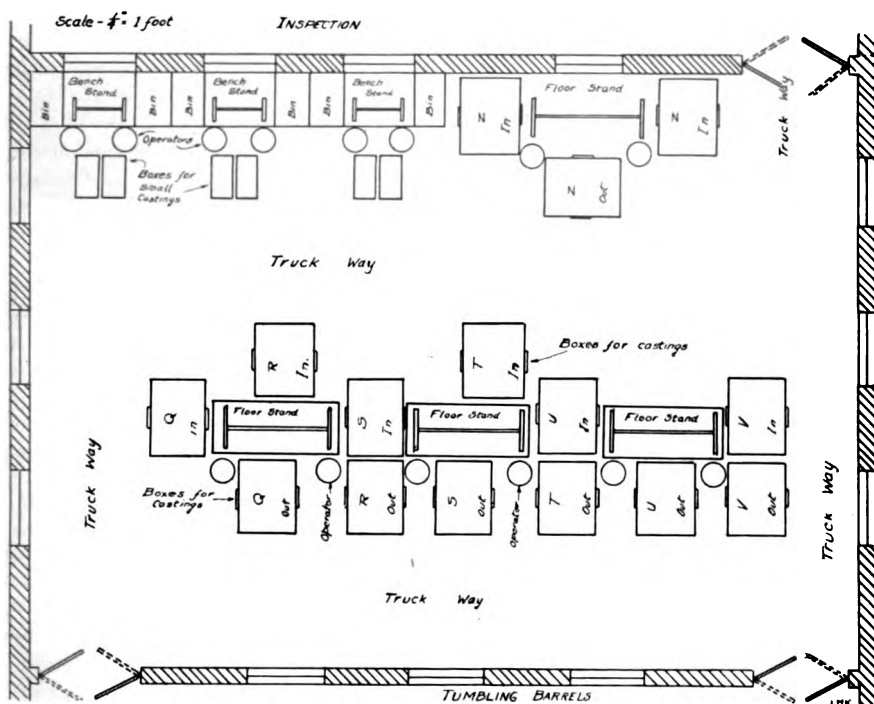


finished pieces without interruptions and interferences so that the work can be kept going continuously are the first considerations. To effect this, the castings must be placed within easy reach so that the operator can grasp them with one hand and deposit them into a container with the other hand, without turning the body excessively. This, of course, applies to the small and medium castings only.

Bench stands can be arranged along a wall upon solid benches and placed as shown in the sketch. The small castings

Floor stands are best arranged in a line at a sufficient distance from any wall or other machines so that the boxes of castings can be fed to them from one side and taken away at the other with ample room for the truck.

A good box for the floor-stand castings is one about 3' x 4' mounted upon two 12" diameter wheels at the center and 3" casters on each corner, which will clear the floor by $\frac{1}{2}$ " when the box is level. Such a box can be readily shifted about by the operators and also be bodily lifted



Showing Plan of Arrangement in a Foundry Cleaning Room

are easily shovelled into the bins at the side of each wheel. The grinder is then in a position to handle them most rapidly—depositing the finished pieces into small kegs or boxes which stand on the floor beside him and which the truckman can readily take away.

by an electric lift truck, or pulled about by a tractor.

The Grinding Wheel and Machine

Is it because grinding costs are seldom placed under observation that so little thought is given to the grinding equip-



ment? The greatest success of any machine is in its running free from vibration. Vibration in a turbine or gas motor is highly detrimental. In other types it is bad because it hastens depreciation and increases cost of repairs. In a grinding stand it does several things. First, it aggravates the operator, makes him dissatisfied, and tires him. Second, it wears away the grinding wheel because of the continual hammering and tends to make it constantly out of round. The operator then trues the wheel to remedy this condition, thereby again wasting wheel material. Third, depreciation and repair items become alarmingly great. This is not mere theorizing. Many cases of increased wheel wear could be cited. Only recently one came under our observation. In one foundry where the machine equipment was very light, poorly mounted, and in bad condition with regard to bearings the wheel wear was 1.13 cubic inches per hour. In another where the wheels were mounted on medium-heavy machines and rather well kept, but using the same wheel as to size, grain, and grade, the abrasive consumption was only 0.58 cubic inch per hour, or one-half the amount. In both cases the castings ground were identically the same.

Vibration can be greatly reduced by the use of heavy machines bolted securely to a concrete floor. This is necessary to absorb the slightly out of balance condition that any grinding wheel may inherently have or acquire when worn slightly out of round.

The Wheel

Cast iron is a metal of comparatively low tensile strength. Because of this, carbide of silicon should be employed as the abrasive. This is called Crystolon by the Norton Company and is a tremendously hard substance and just brittle enough to shatter when necessary. This, in connection with the correct grain size and bond strength of wheel, produces an

efficient tool. The great question generally is what grain and grade (bond strength) must the wheel be for snagging cast-iron castings. Offhand, grain 20 grade S might be recommended, but different conditions so influence the selection that a test is often advisable. The wheel should be of such a bond strength that grains shall tear out of their setting when dulled, and of such a grain size that penetration shall be a maximum unless the finish required enters into the operation. Such a wheel would require little dressing for the purpose of sharpening the wheel face.

The great factors that affect wheel selection are:

1. Type and condition of machine
2. Material, size and shape of castings
3. Speed of wheel
4. Personal factor due to operator

We cited above a case of *poor* versus *good* machine equipment and the effect on wheel wear. To remedy the abnormally excessive wheel consumption much harder wheels were installed. This had the desired effect of prolonging the life as well as better preserving the shape of the face, but at a sacrifice of the cutting. However, it was more efficient to use the harder wheel in spite of the slight decrease in cutting in that particular case.

Large castings generally require a coarser, harder wheel than small castings. This is because the pressure exerted by the operator is usually greater. Also the inertia or that property which governs the rebound of the casting from the wheel is greater. In general, the greater the mass of the casting is, in comparison to the mass of wheel, the harder must be the wheel, other things being equal. Coarse grinding wheels remove metal most rapidly when the castings are soft. This is readily understood when grain penetration is remembered. On the other hand, for harder castings or castings having a hard skin, slightly finer grained wheels are best. In addition to these considerations of the castings is the shape. Thus stove



plates, for example, where the grinding is always the removal of sharp fins and flashes and where the wheel edge is constantly used for cleaning corners, a finer, harder wheel must obviously be used, because of the dressing action and the small contact of work on wheel.

By personal factor is meant the aggressiveness of the workman. When on piece work it is very noticeable that the men "punish" the wheel more than when on day rate. Under such conditions of increased pressure and roughness a harder wheel must be employed.

For efficient running according to the design of the wheel it should never run much less than 5,000 s. f. p. m. nor more than 6,000 for safety's sake. The importance of maintaining this speed between these two limits cannot be expressed too strongly. As the wheel speed decreases, the rate of cutting decreases proportionally, provided the pressure is maintained equally and the wheel wear in cubic inches per unit of product increases. The first is quite obvious, if each grain is considered in the light of a tooth on a cutter. The second is true because the wheel acts softer as the wheel decreases in peripheral speed.

There is, therefore, a double loss — production and wheel structure. In practice, when a piece rate is in use, an operator must exert more pressure upon the wheel so that a greater chip may be cut by each grain to compensate for the loss in speed. This causes excessive wheel wear. The total life of a snagging wheel is from 20 to 30% less than one might suppose when calculating from the life of the first half-inch of diameter consumed. This is in reference to wheels 16" and over in diameter.

Because of the vital importance in maintaining the proper wheel speeds, many foundries have adopted proper methods to effect this when their stands are not self-contained and equipped with variable-speed motors and when they are not belted to jack shafts with cone pulleys. This is

by using the same wheel successively on two or three different machines, each having successively a higher speed. For example, a 20" wheel is worn down to 16" diameter on one machine having an r. p. m. of about 1,125. It is then taken off and mounted on a second machine the r. p. m. of which is about 1,450, and lastly at 12" it is put on a bench stand, the spindle of which revolves at about 1,900 r. p. m.

In the modern core room one usually finds a wheel in operation for cutting off cores. This operation can be done very nicely on a grain 24 Crystolon rubber wheel $\frac{1}{8}$ " in thickness, and usually from 12 to 14" in diameter.

There should also be a wheel operating in a convenient place for the chippers to sharpen their chisels and upon which the moulders can keep their shovels straight and sharp. Such a wheel must be finer and softer than the snagging wheel in the cleaning room so as not to draw the temper from the tools. For this a wheel made of Alundum in grain 36 grade O or P can safely be recommended.

The selection of the proper wheel, therefore, in the cleaning room is a great step toward reducing both overhead and labor costs.

Payment of Labor

In many cleaning rooms the operators are still paid by the hour. This practice is buying time rather than work done. Whenever a piece-rate system can be installed, the step should be taken without further question.

The increased production is almost always remarkable. Even if production increase were alone the result and the piece rate were such as would be figured from old performances at day rate, there would be a large decrease in overhead. Thus, at \$1 an hour per man overhead, an increase in production of 50% means a reduction of 33% in the overhead charge per unit of product, or approximately \$3 per day per man for a nine-hour day. For ex-



INDIVIDUAL RECORD SHEET

Workman No. 116

	H	I	J	K	L	M	N	O	P	Q	R	S	T
Wheel Make and Specification	Machine Number	Class of Castings	Date and Diameter on	Date and Diameter off	Total working hours in use	Volume of Wheel used (cu. in.)	Total Tons of Castings ground	Total Earnings of Operator	Cost of Wheel Material consumed	Wheel cost per ton of Castings	Overhead cost per ton of Castings	Labor cost per ton of Castings ground	Total grinding cost per ton
Norton 20 x 2—24R	18	C	Jul. 18 20"	Sept. 3 16"	375	226	300	\$261	\$9.04	\$0.030	\$1.250	\$0.90	\$2.180
Norton 20 x 2—20S	18	C	Sept. 3 20"	Oct. 28 16"	450	226	335	301	9.04	0.027	1.345	0.90	2.272

I = Class of castings which are from 7 to 60 pounds.
M = Cubic inches of wheel structure consumed = $2\pi(R^2 - r^2) = 2 \times 3.1416(100 - 64)$. R = radius of 20" wheel, r of 16".

P = If wheel is finally discarded at 9" diameter, the available abrasive material costs 4 cents per cubic inch. This can be figured by looking up list price of Crystolon wheel minus 50% discount and dividing by the number of cubic inches the wheel has outside of the 9" center which is discarded.

$$Q = P + N.$$

$$R = L \text{ multiplied by the overhead per hour (which in this case equals \$1.00) divided by } N = \frac{L(1.00)}{N}$$

S = Labor cost per ton—piece rate or figured from hourly rate. This case is piece rate.

$$T = Q + R + S.$$

ample, if 1,000 pounds of a certain size casting could be snagged in one hour and an increase in production of 50% were effected, the operator would then grind 1,500 pounds in the same time. The overhead charge at \$1 per hour would be \$1 per 1,000 pounds before the 50% production increase and \$.66 per 1,000 pounds after the increase, or a 33% decrease per 1,000 pounds of castings ground. The success of this system is in the setting of the rates based on scientific principles.

Large industrial foundries have no trouble in this respect because here there is a constant duplication of parts for which an accurate rate can be set either per 100 pieces or per ton. A jobbing foundry finds it more difficult, but even here it might be accomplished. By dividing the castings, which can be ground on floor

or bench stands, into three groups, A, B, and C, the rate per ton for each can be quite satisfactorily determined. Such a classification would be approximately such that group A castings contained those weighing approximately $1\frac{1}{2}$ pounds and less, group B from $1\frac{1}{2}$ to 7 pounds, and group C from 7 to 60 pounds. All group A castings would be ground on bench stands, while B and C would be ground on the floor stands. For class A, from 200 to 500 pounds could perhaps be snagged per hour or an average of perhaps 350 pounds per hour per man. Perhaps 800 pounds per hour could be done for the intermediate and 1,500 pounds per hour per man for the class C castings. If it was found that these figures held such an average over a period of a month, the basic rate could then be determined.



Under such conditions the operators become keen observers of wheel action and favor the fast-cutting wheel which is economical even at the sacrifice of long life, because the saving due to increased production is much greater than that lost by increased wheel cost in the cast-iron cleaning room.

Grinding Costs

A record kept by the foreman as to the performance of wheels and operators enables one to detect instantly the good and poor workman, the average life and productiveness of wheels in comparison

to new trial wheels that are being tested. The actual cost of grinding which is the sum of three factors—wheel cost, overhead cost, labor cost—enables the foreman to direct his energies toward their reduction. A record of this kind also enables one to determine the feasibility of instituting the piece-rate system and a fair idea of the rates which might be set. On page 6 is shown a record sheet for each workman. The most efficient wheel to use will show itself very quickly in the final column—the total grinding cost.

Notes from the Files of the Sales Engineering Department

A Few Helpful Hints for the Foundryman

How to Order Snagging Wheels

To fill an order for snagging wheels properly, it is necessary to know all of the dimensions—whether the wheels are to be straight or tapered on the sides, whether a straight or oval face is required, and what grain and grade are desired.

For instance, an order properly filled out will read as follows:

100 wheels 20 x 2 x 2", $\frac{3}{4}$ " taper
per foot both sides, straight
face, grain 10, grade U, Alun-
dum vitrified

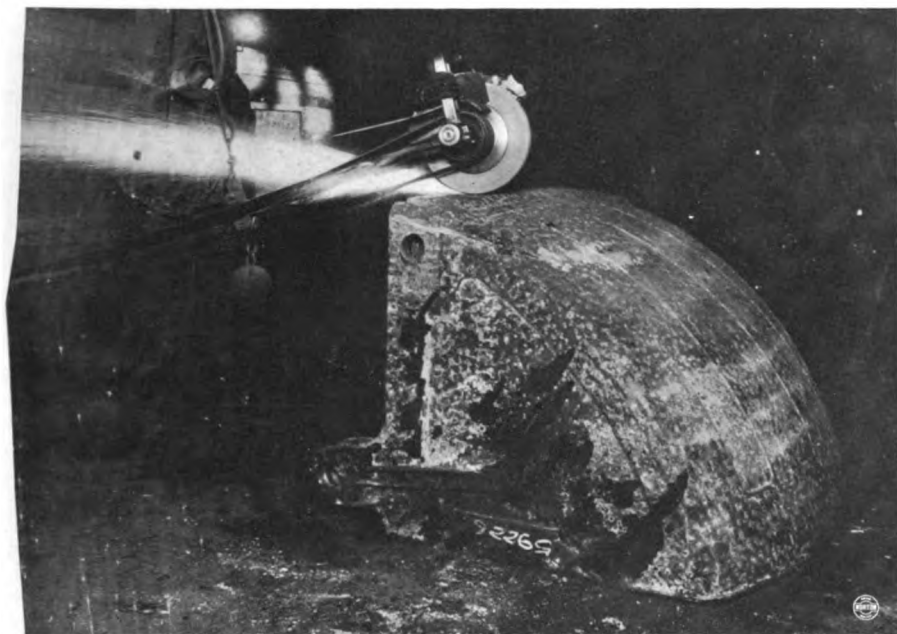


Off Hand Grinding—Using Floor Stand Mounting Tapered Wheels



GENERAL RECOMMENDATIONS

Materials	Machines	Grains	Grades	Abrasive
Open hearth steel	Swing frames Floor stands Small bench stands Portable	10 to 12 12 to 16 24 to 36 16 to 24	S to W Q to S O to Q Q to S	Alundum " " "
High speed and high carbon billets	Swing frames Portable	12 to 20 16 to 20	Q to S Q	Alundum "
Manganese steel	Swing frames Floor stands	6614 6614 to 6616	Q to U Q to T	66 Alundum "
Gray iron	Swing frames Floor stands Small bench stands Portable	16 to 24 16 to 24 24 to 36 24	R to U R to U P to R S to U	Crystolon " " "
Aluminum	Floor stands	30 to 46 24 to 30	4 to 6 P to Q	Crys. & Alun. Elastic Crystolon
Brass and bronze	Floor stands Small bench stands	24 to 30 30 to 46	P to R M to P	Crystolon "
Unannealed malleable iron	Floor stands Small bench stands	16 to 24 24 to 36	R to U O to R	Crystolon "
Chilled iron	Same as unannealed malleable iron			
Annealed malleable iron	Floor stands Small bench stands	10 to 14 24 to 36	Q to U O to Q	Alundum "



Grinding a Clam Shell Bucket, Using a Swing Frame Machine

If these wheels are regularly ordered, it is helpful if in addition to this information the Norton order number of the last or next to the last shipment of wheels is included. This makes it possible to consult past records and to check the specifications as given in the order and often saves writing a letter asking for additional information.

How to Store and Handle Snagging Wheels

Snagging wheels are packed in sawdust in boxes or barrels and leave the plant in a way which should safeguard the contents against the roughest sort of treatment in transit. When these wheels are unpacked, a reasonable amount of care should be used and if, as rarely happens, some of the wheels are broken, this breakage should be reported at once. They should all be examined to see that

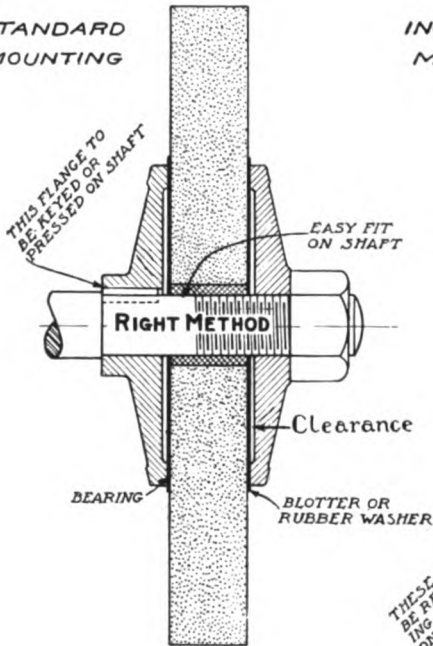
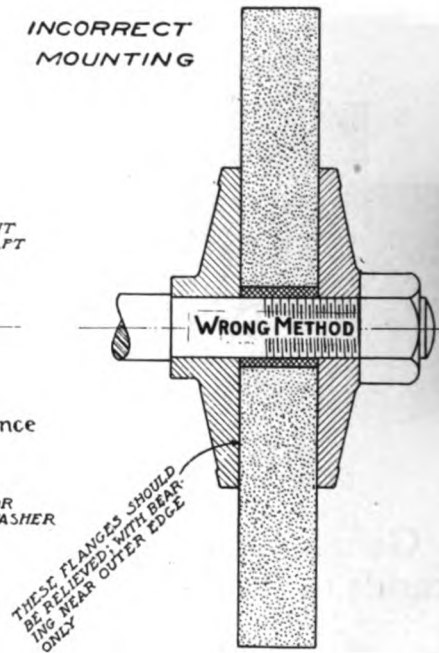
the grain and grade and other specifications correspond with the original order.

Each wheel should be tapped with a wooden mallet. A clear ring indicates that the wheel is sound. This test should be made when the wheels are perfectly dry and free from sawdust. The wheels should be stored in racks so constructed that there will be no chance of rolling in case of some unusual vibration.

If further information is desired, a copy of the booklet, "Storage, Handling and Supervision of Grinding Wheels," will be mailed upon request.

How Snagging Wheels Should be Mounted

Great care should be taken in mounting snagging wheels. Details of mounting, flanges and general safety suggestions are discussed in the booklet, "Safety as Applied to Grinding Wheels," a copy of which will be mailed on request.

**STANDARD
MOUNTING****INCORRECT
MOUNTING****Illustrating the Right and Wrong Method of Mounting**

Practical Helps

Wheels Act Soft and Wear Out Too Quickly

1. If speed is below 5,000, increase to 6,000 s. f. p. m.
2. Try a harder wheel
3. Try a finer wheel
4. Set machines on firm foundation

Wheels Act Hard

Wheels Glaze

Wheels Burn

1. Reduce speed if above 6,000 s. f. p. m.
2. Try a coarser wheel, even as coarse as 10 for large wheels

3. Try a softer wheel

Wheel Loads

1. Increase speed to between 5,000 and 6,000 s. f. p. m.
2. Try a coarser wheel
3. Try a softer wheel
4. Try an 0115 treated wheel

Wheels Get Out of Round Quickly

1. Adjust bearings of the machine and rebabbitt if necessary
2. Try a harder wheel
3. Try a finer wheel
4. Eliminate vibration

Snagging wheels should be operated at between 5,000 and 6,000 surface feet per minute. To get constant results the surface speed must be kept between these limits at all times. This may be done by changing the wheels as they wear to machines running at higher revolutions per minute or by using machines equipped with cone pulleys.



tion and low depreciation under hard service.

Types and Sizes

Norton grinding wheel stands are built in two types and two styles—types P and R, and both bench and floor styles. Type P bench machines are made in five sizes designated as 6", 8", 10", 12" and 14" having respectively $\frac{1}{2}$ ", $\frac{3}{8}$ ", $\frac{3}{4}$ ", 1" and $1\frac{1}{4}$ " spindles. Type P floor machine is built in sizes known as 14", 16", 20" and 24" carrying respectively $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", $1\frac{3}{4}$ ", 2" spindles.

The bench machine Type Q is furnished in 10", 12" and 14" sizes with $\frac{3}{4}$ ", 1" and $1\frac{1}{4}$ " spindles respectively. In the floor machines of this type 14", 16", 20" and 24" sizes are made with $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", $1\frac{3}{4}$ " and 2" spindles.

Prices and complete specifications will be furnished on request. Write for the booklet entitled "Grinding Wheel Stand in the Machine Shop."

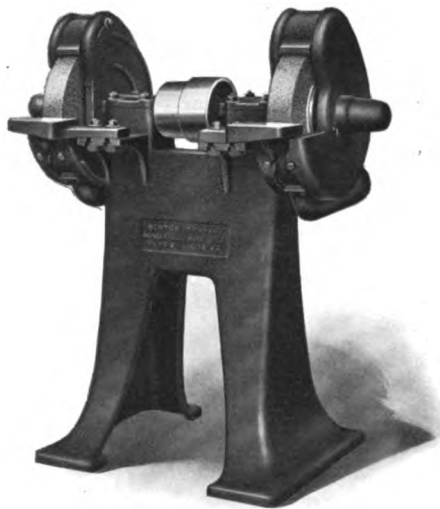
Grinding Wheel Stands in the Machine Shop

Perhaps no equipment in the machine shop of average size gets more universal use and more consistent abuse than a floor or bench machine for hand grinding. Every miscellaneous grinding job in the shop—from sharpening a lead pencil to snagging a casting—goes to such a machine.

Too often it is felt that inasmuch as a machine like this is subject to hard usage "any old machine" will do. As a matter of fact the reverse is true. If high depreciation is to be avoided, if efficiency and economy are to be considered, a machine of proper design and good quality is the only equipment. Continuous good service and low maintenance cost are the prime considerations rather than small first cost.

Appreciation of the foregoing facts has led the Norton Company to develop a line of bench and floor stands possessing features of design and construction that would insure long life, continuous opera-

[OCTOBER, 1920]



Type P Floor Stand

[11]



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the
Grinding Industry that have Appeared in
Recent Issues

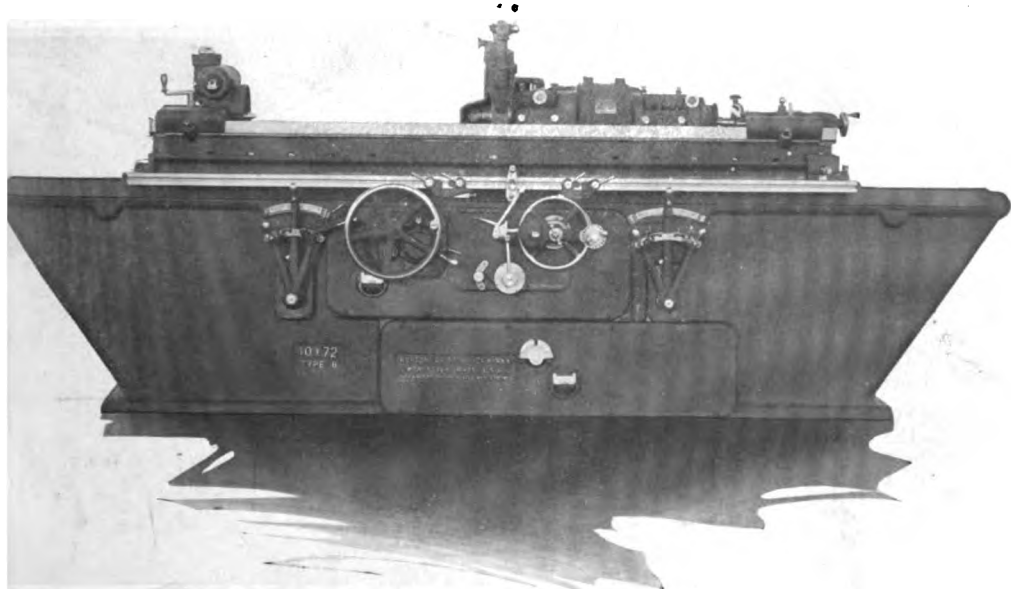
- Making the Essex Piston Pin. *American Machinist*, August 12, 1920, page 317. This article consists almost wholly of illustrations. The grinding operations are (1) grinding bevel in ends; (2) grinding the groove; and (3) grinding the outside.
- Grinding a Radius on a Gage. *American Machinist*, August 12, 1920, page 326.
- Arbor for Grinding Clutch Parts. *American Machinist*, European edition, July 31, 1920, page 95E.
- Machining Monel-Metal Castings. *American Machinist*, August 19, 1920, page 341. Most of this article describes the methods of grinding the lathe tool.
- Use and Abuse of Twist Drills. *Iron Age*, August 19, 1920, page 461. This article gives grinding rules and examples of incorrect grinding and the results and discusses speeds and feeds.
- The Van Norman No. 9 Hole-Grinding Machine. *American Machinist*, July 29, 1920, page 229. The grinding machine illustrated and described in this article has been brought out by the Van Norman Machine Tool Co., Springfield, Mass.
- High-Speed-Steel Tools for Turning Tires. *American Machinist*, August 5, 1920, page 265. The method of grinding the top face of the tool in preparing it for service and for resharpening it as it becomes worn in operation is illustrated.
- Moor Milling and Grinding Attachment. *American Machinist*, August 5, 1920, page 288. A short description of the attachment recently placed on the market by the Eccles & Smith Co., San Francisco, Cal.
- Face Grinding Table for Badger Grinder. *Iron Age*, August 26, 1920, page 527. The Badger Tool Co., Beloit, Wis., has developed a new face grinding table to be used on its regular line of single spindle disk and cylinder wheel grinders.
- Internal Grinding Chucks. *Machinery*, September, 1920, page 10.
- Sharpening Hobs and Cutters. *Machinery*, September, 1920, page 11. This article discusses the important points to be considered when grinding hobs and cutters if good results are to be obtained.
- Manufacturing Three-Area Contact Ball Bearings. *Machinery*, September, 1920, page 34. The grinding practice described is done at the shops of the Federal Bearings Co., Inc., Poughkeepsie, N. Y.
- Quantity Production of Combination Limit Plug Gages. *Machinery*, September, 1920, page 59. Description of a new system of limit plug gages developed by the Taft-Peirce Mfg. Co., Woonsocket, R. I., and the grinding methods employed in their manufacture.
- Cincinnati Internal Grinding Machine. *Machinery*, September, 1920, page 85. A rather lengthy description of the No. 9 internal grinding machine recently developed by the Cincinnati Grinder Co., Cincinnati, Ohio.
- Guard for Modern Tool Co.'s Grinder. *Machinery*, September, 1920, page 92. A brief summary of the advantageous features of the new guard made for the plain grinding machines of the Modern Tool Co., Second and State Streets, Erie, Pa.

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GRITS and GRINDS

NOVEMBER, 1920





Grits and Grinds

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The Advent of a New Era in Cylindrical Grinding

By W. H. CHAPMAN, *Grinding Engineer*

The Norton Company has recently announced a new type of cylindrical grinding machine designed to handle quantity production of rather long cylinders of the usual diameters.

The machine is the practical demonstration of the designer's theory that production was limited by the traverse speed of the work relative to the wheel face. A wheel can be fed only so far economically and grind properly. The work must rotate at a reasonable rate to obtain good wheel action for the grades of wheel in common use. The only other way to increase production, then, is to get more *length* of bar into contact with the wheel per minute.

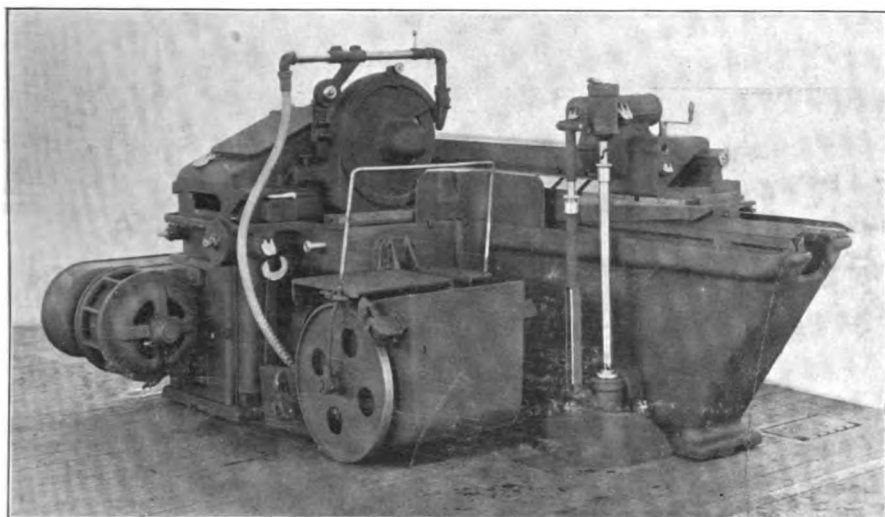
Fortunately wheel stress is decreased as the work speed increases and allows corresponding increase of work speeds so that the wheel face may always be made to just cover the traverse advance per work revolution even with narrow faced wheels. The machine speeds in this new type, which is designated as Type B, are interrelated to easily obtain this condition for whatever width of wheel is chosen.

Wheels of about one grade softer are used as compared to the same job when done on the slow traverse machine. Where the older, or A Type, Norton machines

were the best producers in their field, the new type will usually show from 100% to 400% increase in production rate, according to nature of the work, while wheel wear per cubic inch of material removed is not appreciably increased even though softer wheels are used.

The effect in machine earnings is enormous. As an example: On machine steel shafts, 36" long and $1\frac{1}{8}$ " in diameter, the old machine finished seven or eight per hour, removing about .005" from the diameter with limits of plus or minus .0005". Each shaft was handled twice to take care of the dog zone. The Type B machine did the same work at the rate of 37 shafts per hour under the same conditions of limits and finish.

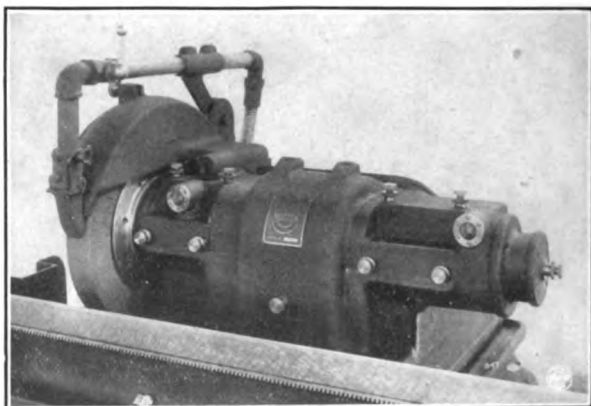
As a comparison of the cost entailed in producing the shafts in each case, the following is most interesting: The cost of operating the Type A is about 4 cents per minute, based on a nine-hour day, wage of 75 cents per hour, and burden of \$1.65 for depreciation, rent, heat, power, diamond cost, etc. For the B Type this same cost is 5 cents, based on a 75-cent wage and \$2.25 burden. The wheel wear was less than one cubic inch per hour. The wheel is worth 7 cents per cubic inch (less stub). Wheel



Rear View of the New Norton Self-Contained Cylindrical Grinding Machine.—Type B



Rear View Showing Electric Motor Drive

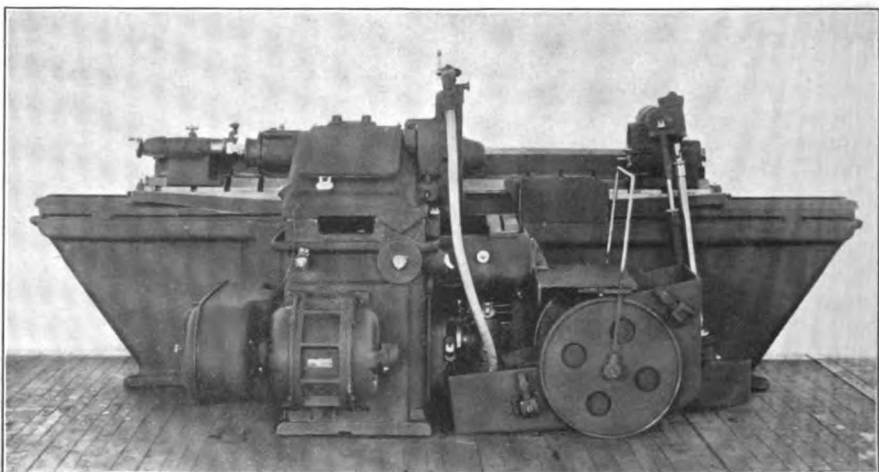


Detail view of Wheel-head, showing Adjustment Screws for Bearing Boxes

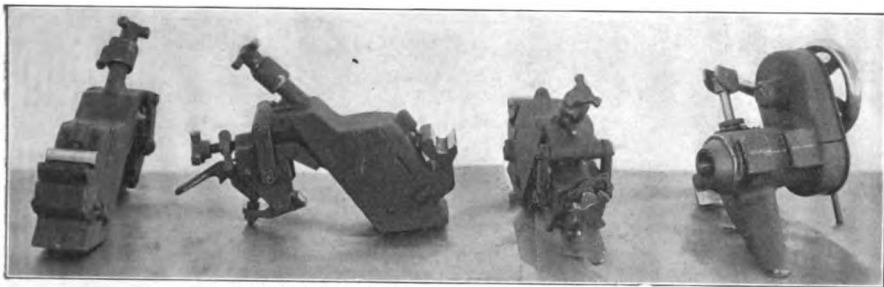
wear was therefore negligible. The first machine cost \$2.40 in producing, say, eight shafts; the B Type cost \$3 in producing 37 shafts. The eight shafts cost 30 cents each and the 37 cost 8.1 cents each. The saving for the 37 shafts over the cost of doing them in the A Type machine is $37 \times \$(.30 - .081)$ or \$8.10 per hour. At this rate it would take less than 800 hours to pay for the B Type machine.

As to the details of design and construction, it will suffice to say that the machine has been made to provide great rigidity and strength wherever necessary and that mass has been carefully distributed to reduce any effects of vibration.

The spindle is provided with a new type of journal bearings and all adjustments are made while the spindle is running. It is impossible to stick the



Rear of Machine showing Settling Tank in Place

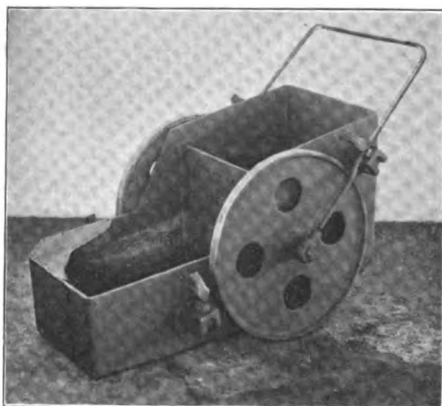


Showing Steadyrests and Center Pointing Device

spindle. The belt pull is downward, keeping the wheel slide firmly on its ways under the heaviest cuts. The bearings throughout have been carefully selected, the spindle and driveshaft bearings alone being of the plain type and all others being of the ball type. There are only two belts, one from the motor to the driveshaft and the other from the driveshaft to the spindle. Automobile type selective gear transmissions are used to control table and work speeds and an ingenious reversing mechanism is employed to get absolutely smooth operation of the table at the high speeds used. Work speed ranges are from 53 to 167 revolutions per minute. Table speeds are from 10 feet to 32.6 feet per minute and wheels from $2\frac{1}{2}$ " to 6" in width are provided for. The standard wheel furnished with the machine is 18" in diameter $2\frac{1}{2}$ " wide with a 10" hole and $12\frac{3}{8}$ " countersink on both sides. The motor is provided as an integral built-in part of the machine. The grinding compound is contained in a portable tank which may be wheeled away and dumped at any time and greatly reduces the time usually lost in cleaning out the machine.



Headstock of the new B-10



Settling Tank Removed from Machine for Cleaning



The machine is known as a self-contained type and is so completely a unit that it requires absolutely no auxiliaries to function properly. In fact the machine has been operated when swung clear from the floor and while hanging in the sling of a crane.

From time to time the Norton Company will publish records of production of this remarkable new machine and we feel sure that you will be interested in seeing what it can do on your line of work.

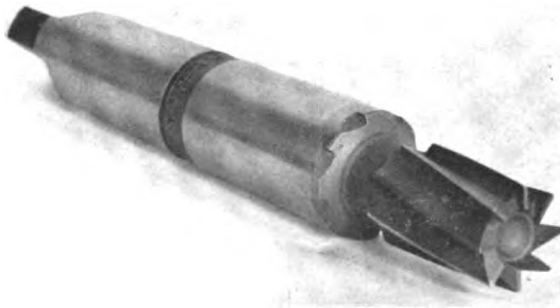
Notes from the Files of the Sales Engineering Department

Grinding End Mill With One Center Hole

In grinding an end mill like that shown in the illustration, the common practice is to put one end on the center and use a steadyrest in the middle. If the mill has an opening in the end, like the one il-

lustrated, it can be held rigidly between centers by placing a steel ball between this opening and a female center.

Wheels in 6646-J or K are used successfully on this work.



End Mill with opening in one end ground with an Alundum Wheel

Machine Division Branch Offices Open at Various Points to Give Service



Hans Wickstrom
Chief Demonstrator



H. W. Cudworth
District Manager
Chicago



Oscar Knight
Dist. Manager
Detroit



Harry Harding
Foreign Dist. Manager



George C. Montague
Dist. Manager for New England



J. H. Peckham
District Rep., Hartford

The Norton Company, realizing the importance of direct contact with those engaged in grinding problems, has opened several branch offices in important industrial centers and offers the grinding machine user opportunities for furthering the grinding art by giving first-hand service. Grinding, unlike other machine tool operations, is becoming more and more highly specialized.

These branch offices are manned by experts in grinding matters and their services will be devoted to the interests of our customers.

The industries of grinding machine users in Philadelphia and vicinity will be served through the office located at 324 Bulletin Building, Philadelphia, with Paul Hoffman, district manager. Western Pennsylvania interests will be handled through the branch office at 230 Fifth Avenue, Room 200, Pittsburgh, under the direction of Paul R. Hawkins, district manager.

John Cook is district representative at 206 Keith Theater Building, Syracuse, and Walter Rogers has received a similar



Paul Hoffman
District Manager in
Philadelphia



Paul R. Hawkins
District Manager in
Pittsburgh



John Cook
District Rep., Syracuse



J. Herbert Johnson
Acting District Manager
New York



Walter Rogers
District Rep.
Indianapolis



O. E. Nordstrom
District Manager
Cleveland

appointment in Indianapolis with the service station located at 241 North Pennsylvania Avenue.

The New England district is under the management of George C. Montague whose long experience with grinding wheels and grinding machines stands as a guarantee of satisfactory service to New England factories.

Southern New England will be served through the Hartford office located at 603 Phoenix Mutual Life Insurance Building, 49 Pearl Street, under the direction of J. H. Peckham, district representative.

Cleveland interests are handled through the office at 442 Engineers' Building under the direction of Oscar E. Nordstrom, district manager.

The New York Machine Division office shares quarters with the wheel store and office at 151 Chambers Street. This office is under the direction of J. Herbert Johnson, acting district manager.

The Norton stores situated at 11 North Jefferson Street, Chicago, and 73 West Congress Street, Detroit, with their efficient corps of machine men continue to give their ready assistance to the machine user in these vicinities. H. N. Cudworth is district manager in Chicago, and Oscar Knight is district manager in Detroit. Both men have had long experience in grinding-machine demonstration.

Harry N. Harding, foreign district manager, is not by any means a stranger to the foreign field and his grinding experience goes back many years. The oldest in point of experience of the entire service force is Hans Wickstrom who has been demonstrating Norton machines for a quarter century. His title is Chief Demonstrator and his very expert services can be obtained by any district office when occasion requires them.

In establishing these district offices the foremost thought is the offering of real Norton service to the machine user.



Grinding Cast Iron Piston Rings

By R. H. CANNON

The purpose of the piston ring is to make the combustion chamber gas tight. In time the continual reciprocation of the piston, the corrosive action of the gases, and the excessive pressure wear the cylinder walls and would also wear the piston itself, were it in contact with the walls. Furthermore, especially when aluminum pistons are used, the clearance when the motor is cold must be several thousandths of an inch to allow for expansion of the piston. To prevent loss of power through leakage of gas and to prevent continual fouling of spark plugs from oil, the necessary space between piston and cylinder

is sealed by a ring which continually springs toward the cylinder wall. At the same time its inside edge is imbedded in a groove in the piston. To allow the ring to change slightly in diameter, there is a joint, usually an "angle" joint or a "step" joint. Either type of joint allows some escape of gases so there are always at least two rings on each piston, whose joints are on opposite sides.

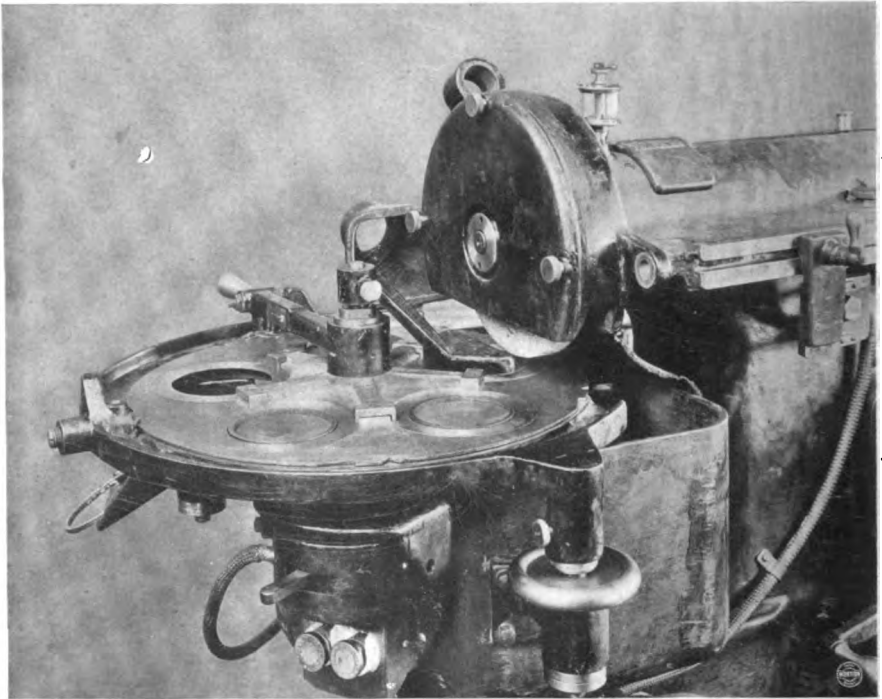
Probably 90% of all piston rings are made of cast iron or semi-steel and are cast in two ways: either singly or in a long cylinder. The latter method is called the "pot castings" method in which the



Grinding Cast Iron Piston Rings—Showing the Surfacing Operation

[NOVEMBER, 1920]

[9]



Surface Grinding of Piston Rings on a Heald Machine—Showing Close-up of Semi-automatic Attachment

pot is turned and bored before it is cut up into rings. In either case the rings have to be surfaced on both sides and ground cylindrically. If they are cast singly, they must be rough ground internally also. When made with the step joint, the joint is touched up with an elastic or rubber wheel after it has been milled out.

Surface Grinding

Surface grinding is the most important operation since it is necessary to keep within very close limits. When rings have been cast singly there are usually two grinding operations—roughing and finishing. When they are made by the pot casting method they seldom have to be rough ground as the sides are already true and parallel and only about .005 is left for grinding.

The finishing operation, and very frequently both roughing and finishing, can be done most economically on a rotary magnetic chuck surface grinding machine which is especially well adapted for this kind of work. A skilled operator can frequently do 750 to 1,000 rings per hour. On one type of machine the wheel slide traverses automatically so that the wheel, when not in contact with the work on the magnetic chuck, is back out of the way. At the same time the current to the magnetic chuck is automatically switched off so that the operator can remove the ring which has just been ground and put another in place. As the wheel comes forward the current is switched on, holding the next ring firmly in place. The simplest method is to feed the rings in one at a time

with one hand and remove them with the other using a non-magnetic hook. Sometimes, however, the manufacturer has special appliances connected to the machine which make it more or less automatic.

Contrary to the general rule in regard to grinding cast iron with Crystolon wheels, Alundum has been found in the case of piston rings to be more satisfactory. The best grains and grades in Alundum as determined from our records of successful trials are 36 to 50 K-L-M. We suggest 46-L for the first trial. Regular Alundum has been used, also No. 38 and No. 66 Alundum. The last mentioned is fast being adopted as the standard. Crystolon wheels in 36-K, L and M and 46-K and L have

been most successful. Grain 36 grade L is the favorite.

Internal Grinding

Internal grinding of piston rings is in no sense a precision operation except in rare cases where one ring fits inside the other, the joints being on opposite sides of the diameter. Nearly all piston rings of course are in one piece; and since the bearing is on the cylinder walls only, the internal operation consists simply of removing burrs and fins from rings which have been cast singly so that they will fit on the arbor for cylindrical grinding. Rings cast in pots are seldom ground internally but are bored before being separated.



**Cylindrical Grinding of Piston Rings on a Norton Machine
Several Rings are Mounted on an Arbor**



There are several methods of internal grinding from free-hand "snagging" on a floor stand to setting up several in a chuck at once and using an internal grinder. We sometimes find the portable electric or pneumatic grinder used for this purpose also. Hard wheels are employed for the most part, those which will take a deep cut and stand up. Finish is not considered but care must be taken if the rings have been slotted that they are not "drawn," that is, heated so that they will not spring apart again when released. The methods used on the internal operation vary so that it is hard to recommend wheels for it. We are listing below a group of both Alundum and Crystolon wheels which have been taken from records of satisfactory trials. The harder ones are for what amounts to snagging work and the softer ones for semi-precision grinding.

Alundum—6636-L, 6646-O

Crystolon—46-O, 30-S

Cylindrical Grinding

To grind piston rings cylindrically they must be put on an arbor and held firmly by end pressure. This is always done after the surfacing operation so that

the sides of each ring will be parallel and smooth and they can be held without slipping. A fairly good finish is required of course for the cylindrical operation since this part of the ring is to be continually in contact with the cylinder walls. At the same time we have to have a wheel which will stand up. On the first cut the surface will be found slightly uneven and the face of the wheel will encounter the sharp edges.

The following Crystolon wheels have been found satisfactory: 36-L, 24 combination L and 30-M, with the latter wheel as the favorite. Alundum wheels which have been tried with success are the following: 36 combination J, 46-J, 46-K, 36-L and 3824 combination L.

If possible, roughing and finishing are done with the same wheel but we frequently find the customer employing two operations. The harder wheels will of course be used for roughing, while grades as soft as J have been used with success when a very good finish was required.

Touching Up Step Joints

For smoothing up the step joints after they have been milled, 60-V7 Alundum elastic wheels will be found satisfactory.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in

Recent Issues

Cadillac Grinding Practice. Machinery, October, 1920, page 103. Description of the methods employed in the grinding department of the Cadillac Motor Car Co., Detroit, Mich.

Machining Aluminum Automobile Parts. Machinery, October, 1920, page 115. An account of the practice followed in the manufacture of the Essex car at the Hudson Motor Car Co., Detroit, Mich.

Standard Tapers for Lathe and Grinding Machine Centers. Machinery, October, 1920, page 141.

Special-Purpose Machines in the LeBlond Plant. Machinery, October, 1920, page

144. The last machine illustrated and described is a Gray planer rigged up for grinding large flat surfaces.

H. E. Harris Thread Grinding Machine. Machinery, October, 1920, page 186. This machine is made by the H. E. Harris Engineering Co., Bridgeport, Conn.

Fraser Automatic Grinding Machine. Machinery, October, 1920, page 189. This machine recently placed on the market by the Warren F. Fraser Co., Westboro, Mass., is designed primarily for grinding rolls.

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GRITS and GRINDS

DEC 17 1920

DECEMBER, 1920



A copy of any of these booklets on Grinding Subjects will be mailed to any one interested on request of NORTON COMPANY PUBLICITY DEPARTMENT



Grits and Grinds

Vol. XII December, 1920

No. 8

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The Multi-Graduated Precision Grinder

By R. H. CANNON

Rapid progress is being made in obtaining the same precision on screw thread surfaces as has been heretofore obtained, commercially speaking, only on cylindrical, flat or spherical surfaces.

The Precision and Thread Grinder Manufacturing Company, 1932 Arch Street, Philadelphia, Pa., is demonstrating improved grinding equipments, comprising several attachments, which can be used in conjunction with any machine tool. They are capable of use on a variety of work, and particularly adapted for thread grinding on lathes.

The Model "D" grinder attachment as shown is a left-hand attachment for use in back of the lathe center. Model "C" is a right-hand attachment for use in front of the lathe center. The construction of models "C" and "D" is identical in all respects with the one exception that they face in opposite directions.

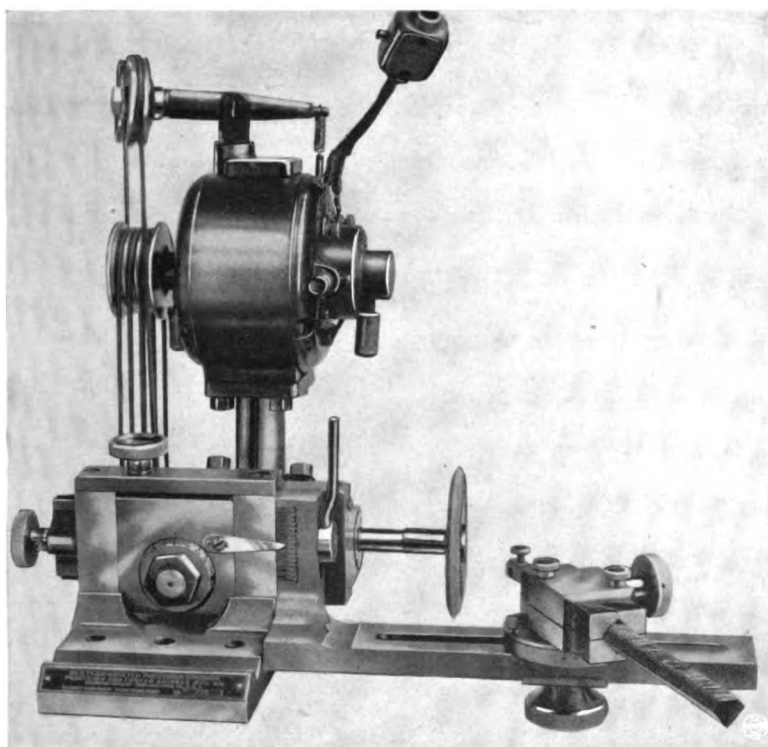
A noticeable improvement is the new-style wheel-truing arm, which is now attached to the base of the grinder in such a way that the thread angle is dressed on the wheel in the same plane with the axis of the work centers, thus producing a perfectly formed thread. It also has positioning pins for quickly locating the angles for "V," U. S., Whitworth, and Acme threads.

The grinding spindle is carried in five precision ball bearings, adjustable for radial wear and end-thrust play,

and is protected from abrasive dust by felt-lined steel bushings. The spindle housing has an oil reservoir.

The spindle housing is on a vertical traverse plate which is indexed with graduations for setting to any angular inclination to conform to the helix angle of the thread. Means are provided for raising and lowering the traverse plate to bring the wheel center into alignment with the work center. The spindle housing is provided with a longitudinal feed traverse, for bringing the wheel into the lead with the thread, and also to shift the cut of the wheel during the grinding operation. In cases of irregular distortion, this cleans up the surfaces in all cases, without the need of leaving a lot of oversize stock for grinding.

An outstanding new feature is the power transmission system, which is accomplished by an endless belt. This belt has a three-point contact with both the driving and driven pulleys and then travels over a compensating two-pulley arrangement, which automatically keeps it at the proper tension to prevent slippage and at the same time slack enough to prevent loss of power and heating. Arrangement for two speeds without changing pulleys is provided for. The slow speed is for external grinding with large wheels and the fast one for internal grinding with small wheels.



Thread Grinding Attachment for Use in Front of the Lathe Center

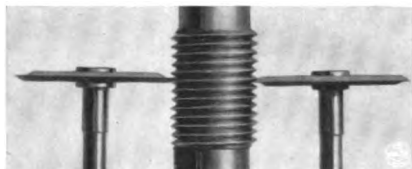
Duplex Thread Grinder

By this arrangement a lot of duplicate pieces may be rapidly ground. After setting the wheels on the first piece of the lot they are not disturbed thereafter, but the following parts are brought into lead with the wheels by means of an adjustable rotating lathe dog.

The wheels are beveled on one side only as shown. Each wheel grinds only on one side of the thread angle and on the root of the thread. Also each wheel grinds on the side of the angle opposite the other wheel. Both wheels grind on the root of the thread simultaneously. This is valuable in getting the sharp bottom in a "V" form of thread. Since there is no included angle point to wear away, the wheels do

not require redressing. The effect is the same as flat grinding with a straight wheel.

Wheels in grain 180 grade M vitrified Alundum are suggested for the first trial. On some kinds of work wheels



Grinding Both Sides of a Thread at Once

as fine as grain 200 and as hard as grade P are very successful. Both 66 and regular Alundum are used.

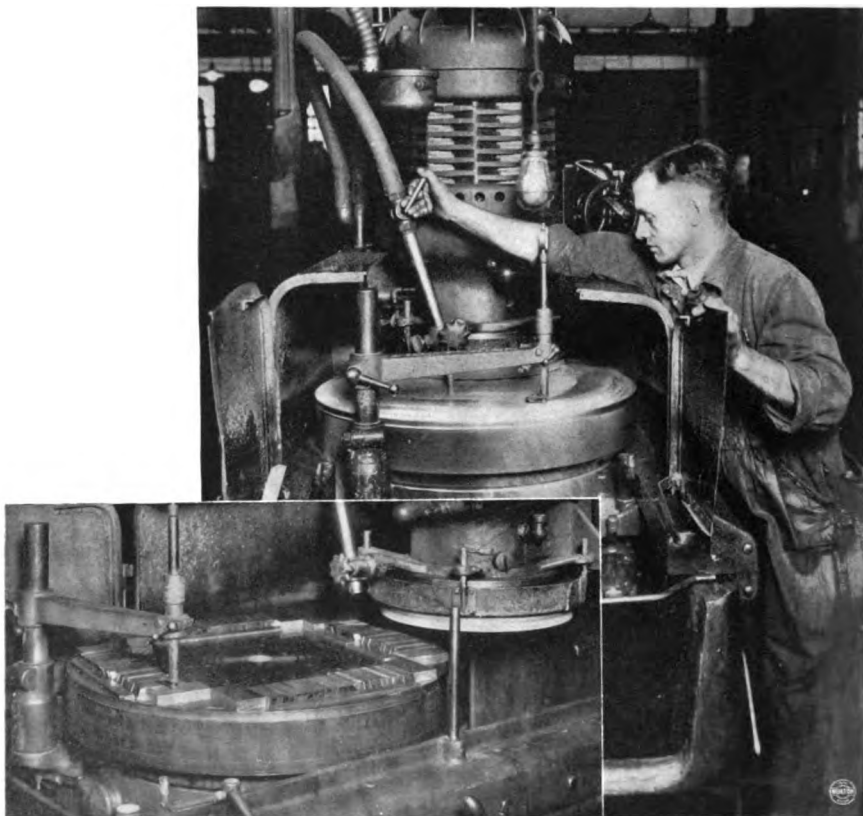


Producing a Stellite Cutter Blade

In view of the increased uses for which Stellite is being employed any information in connection with successful grinding methods should be of interest to those who are using this material.

Through the courtesy of the Continental Tool Works of Detroit, we are privileged to present in detail their method of producing the piece shown here, which is a cutter blade for an 11"

Ingersoll milling cutter head. The material comes into the plant in the form of a bar approximately 11" x $\frac{3}{4}$ " x $\frac{1}{2}$ ". The bar is cut into three pieces $3\frac{1}{2}$ " long on a Racine cutting-off machine using a 30 Rubber wheel, Alundum, 12 x $\frac{1}{2}$ x $\frac{3}{4}$ ". The production on this machine is about 64 per hour and the wheel averages about 54 cuts before wearing out.



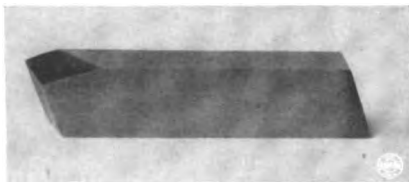
The Four Sides are Ground on a Blanchard Vertical Surface Grinding Machine—
Alundum Wheel

The $3\frac{1}{2}$ " pieces are then ground on a Blanchard vertical surface grinding machine. The four sides are ground and the limit of accuracy is .001". The wheel used is an 18 x 5 x $1\frac{1}{2}$ ", rim 3830-G silicate. Alundum, production averages

about 25 per hour for the four sides, the quantity of material taken off being from .010" to .030". The silicate wheel lasts from three to four days.



Cutting Off Stellite with an Alundum Rubber Wheel



The Finished Blade

The three angles are ground on a Cincinnati cutter grinder employing a cup wheel 5 x $1\frac{1}{2}$ x $\frac{1}{2}$ ", 3846-J Alundum known as Cincinnati shape 4. Production on the cutting of the angles is as follows:

First angle—40 per hour

Second angle—42 per hour

Third angle—48 per hour

Wheels last approximately $1\frac{1}{2}$ hours



Grinding the Angles—Alundum Wheel



Notes from the Files of the Sales Engineering Department

Grinding to a Definite Radius of Curvature

Frequently it is necessary to grind to a definite radius of curvature. If grinding is done on the periphery of a straight wheel and the wheel is not bevelled, its radius must be exactly equal to the radius of curvature desired. Furthermore, as the wheel wears down, the radius of curvature will change.

The proper angle at which a wheel must be bevelled to grind any desired radius of curvature (provided it is greater than the radius of the wheel) can be determined by a simple trigonometric calculation. The explanation is given for a cup wheel because that is the shape recommended for practical work, thus eliminating contact of the work with the spindle.

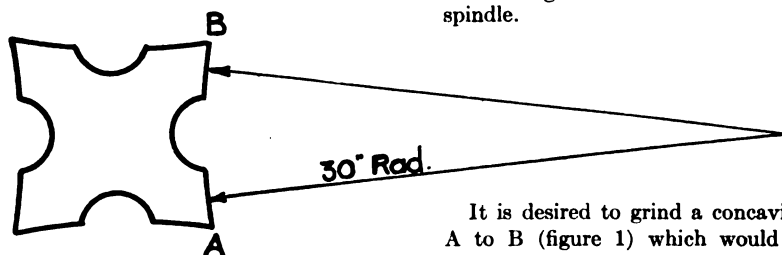


Fig. 1

It is desired to grind a concavity from A to B (figure 1) which would have a 30" radius.

If grinding is done on the side of a cup wheel at M, the radius of curvature will be exactly that of the wheel. If grinding is done on the rim (perpendicular to the spindle) of a cup wheel, the curvature will be that of an infinite radius. It is obvious then that if the face is bevelled at the proper angle, as for instance angle BAC (figure 2), any desired curvature can be obtained. To determine angle

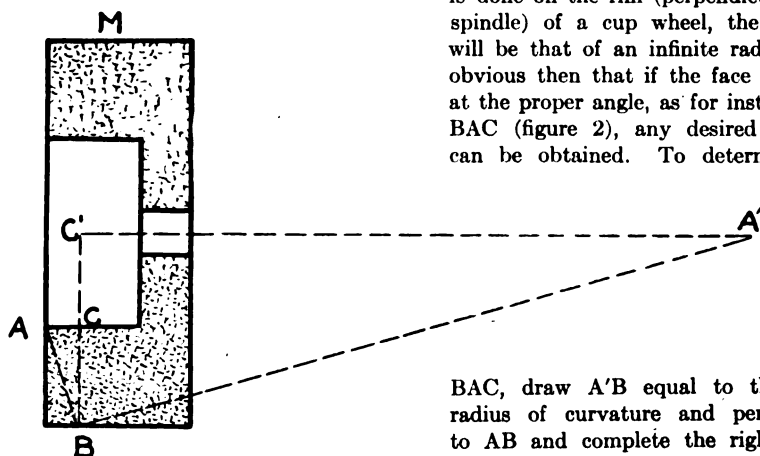


Fig 2

BAC, draw A'B equal to the desired radius of curvature and perpendicular to AB and complete the right triangle A'BC', BC' being the radius of the wheel. Then in the right triangles BAC and A'BC' angle BAC equals angle A'BC'.

Now cosine A'BC' equals

$\frac{BC'}{\text{radius of wheel}}$

A'B desired radius of curvature

Thus, if the radius of the wheel is 10' and the desired radius of curvature is

30', cosine A'BC' equals $\frac{10}{30}$ equals .333

and angle A'BC' (equals angle BAC) equals approximately 70° 32'. Stated in the simplest terms, the rule is: divide the radius of the wheel by the radius of curvature. Look up the angle of which this answer is the cosine. Bevel the rim of the cup wheel till angle BAC equals this angle.

Grinding Experiences for Distribution to Those Interested

Most every man who is at all interested in grinding desires to learn more about it—there is a lot to learn. The grinding industry is comparatively new and we cannot find authentic books on the subject in any library as we can on other subjects.

Your particular attention is called to this month's "Grits and Grinds" cover. The man who has a copy of each of these little booklets can boast of a useful library collection on grinding and grinding wheels. The Norton Company has long realized the importance of preserving its experience in order that others might benefit from it, and from time to time the information it has accumulated is printed in booklet form. None of these booklets is considered a treatise on the subject but each one contains a lot of valuable and useful facts which are the result of experience of engineering experts and practical men in the shops.

If you are interested in any one or all of the following booklets, you may have

a copy by simply writing Norton Company, Publicity Department.

- How to Order Grinding Wheels
- Bushing Grinding Wheels
- Storage, Handling, and Supervision of Grinding Wheels
- Tool Grinding
- Commercial Diamonds for Truing
- Grinding of High-Speed Steel
- Snagging
- Grinding-Wheel Dressers
- Polishing
- Norton Grinding Wheels on the Blanchard Surface Grinding Machine
- Norton Grinding Wheels on the Pratt & Whitney
- Grinding Wheel Stands
- Saw Gumming
- Stellite Grinding
- Principles of Cylindrical Grinding
- Cam Grinding and Cam-Grinding Equipment
- Little Known Facts About Grinding
- Steadyrests—Form Grinding—Grinding of Plane Surfaces

A Correction

"TABLE SPEED" not "WORK SPEED"

In the article entitled "The Advent of a New Era in Cylindrical Grinding," November issue "Grits and Grinds," third paragraph, the first sentence reads, "Fortunately wheel stress will decrease as the work speed increases." It should have read, "Fortunately wheel stress will decrease as the TABLE speed increases."

This was a very serious error and we take this method of emphasizing the correction.

[DECEMBER, 1920]

[7]

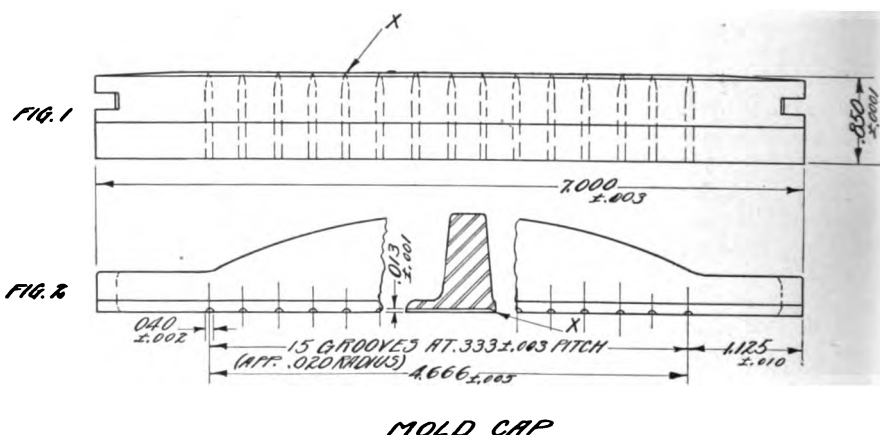


Grinding vs. Milling Mold Caps

By E. B. CUTTER

The cap as shown in figure 1, top view, and figure 2, side view, is made from 1020 S. A. E. specifications, carbonized and heat treated.

at a time in 35 minutes with an attachment made by the Liberty Gauge and Tool Works, Woonsocket, R. I., which is used with a No. 1 B. & S. type surface



The cutting of the groove was formerly done with a gang of fifteen formed cutters.

After milling the grooves, the work was hardened and often was lost owing to warping to such an extent that it was impossible to straighten near enough to surface grind and bring to dimensions given. The Linograph Company of Davenport, Iowa, has saved many of these by stoning grooves, but this has required an average of five hours by a skilled workman.

This company now machines the cap, hardens it, surface grinds to dimensions given, then grinds the fifteen grooves one

grinder. The wheel employed is a 2" x $\frac{3}{8}$ " x $\frac{1}{8}$ " 6690-5 Alundum elastic, face dressed to .020 radius. The wheel speed 20,000 r. p. m., .001 depth of feed, hand cross feed. At X the groove is but .004 deep and just through the side of the cap. One wheel will grind approximately 150 to 200 grooves. A saving of over 600% has been made by this modern method, which is the idea of Mr. L. S. Rasmusen, general superintendent.

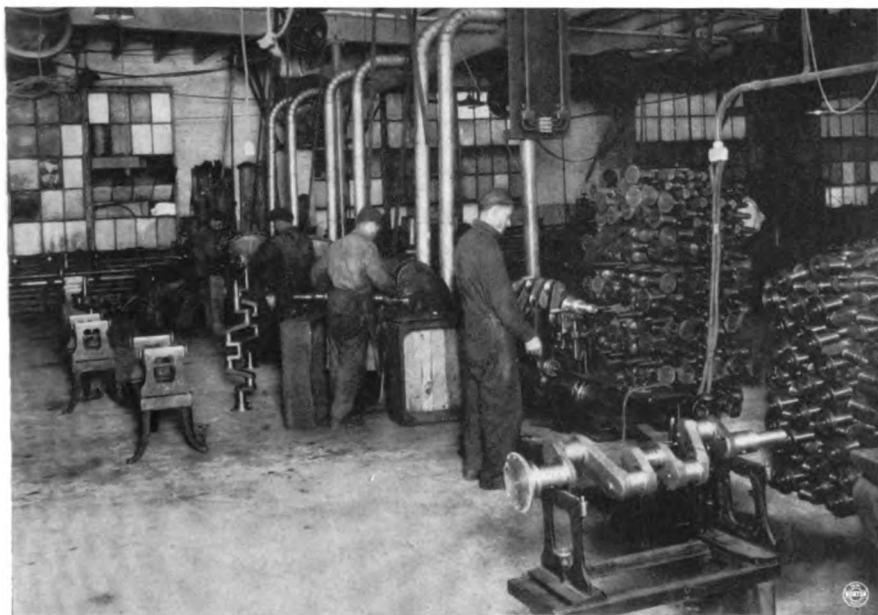
In addition to the saving in time by this method, the finished article is superior to one made by the old method.

How Automobile Crankshafts are Carefully Balanced

The accompanying illustration shows part only of a well-equipped crankshaft-balancing department in the plant of the Automobile Crankshaft Corporation of Detroit, Mich.

There has been no need in recent years for argument in favor of balancing crank-

machines, it will be noted, are conveniently located; and with the aid of the balance-indicating machine commercial balancing is a comparatively simple matter. Balancing is accomplished by snagging off the corners with a heavy grinding wheel. The crankshafts are put in balance at a



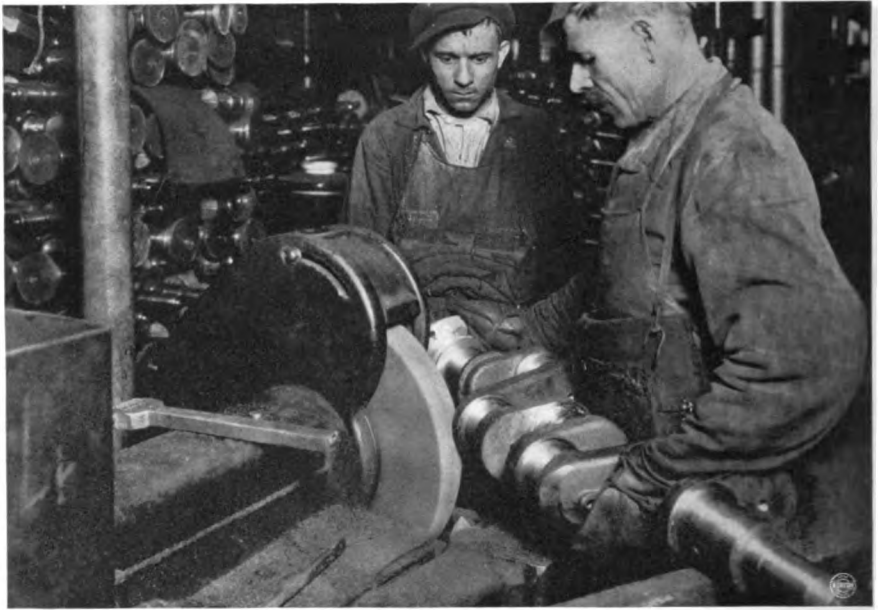
A Well-equipped Crankshaft Balancing Department

shafts when the product is to be used in a truly high-grade motor car. By far the larger proportion of crankshafts made in this plant which are for such cars as the Stutz, Winton, National, Marmon, Cadillac, and tractor motors such as the Waukesha, Weidely, and Midwest are required to be put in running balance. The plant produces crankshafts in a great variety of sizes ranging from 26" to 78" in length and in weights from 25 to 300 pounds.

The balancing equipment consists of three Norton running-balance indicating machines, balancing ways, and several Norton floor stands of the "Q" type. The

speed of either 900, 1,000, or 1,200 revolutions according to requirements.

Removing of the stock is being exclusively done with Alundum wheels grain 16 grade R in a most economical manner because they have three different sizes of machines using wheels with a 3" face 20", 24" and 30" in diameter. It is their practice to remove the 30" diameter wheels from the larger machines after they have worn down to 24" and then again when the 24" have worn down to 20". This enables them to maintain more consistent wheel speeds resulting in cheaper grinding wheel costs.



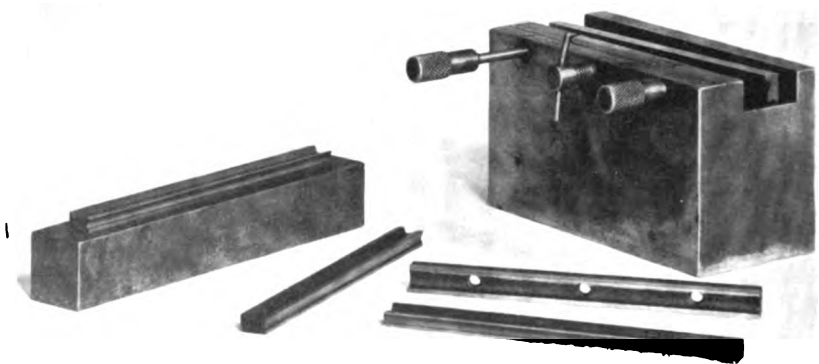
Snagging off the Corners with a 16-R Alundum Wheel to Balance Crankshafts

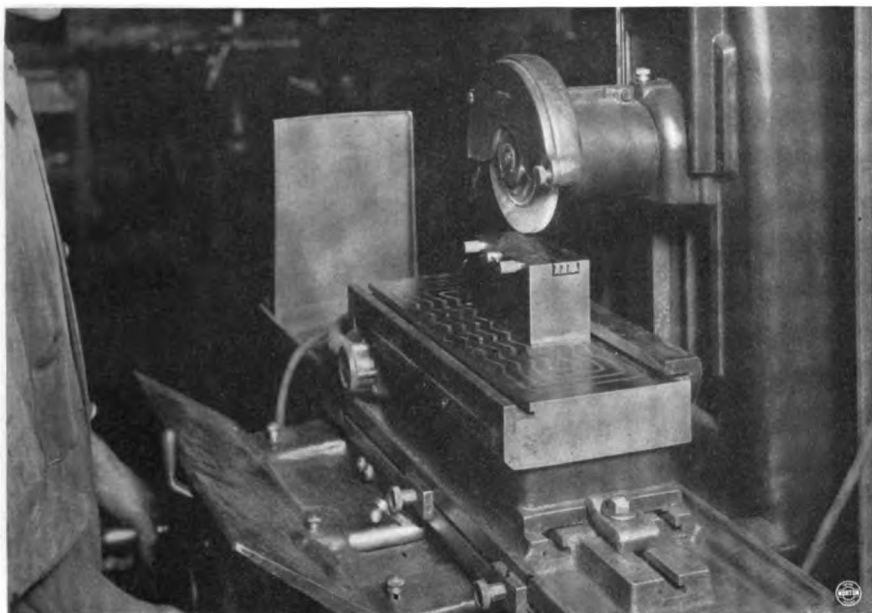
Grinding Thin Reamer Blades

An interesting operation is that of grinding the reamer blades illustrated here, the information and illustrations

for which we are indebted to the Continental Tool Company of Detroit, Mich.

The problem was to keep the blades





Using a Special Fixture to Keep Thin Blades Cool and Straight

straight and cool when grinding. The material is Mohawk high-speed steel $\frac{1}{4} \times \frac{1}{8} \times 5\frac{1}{2}$ " over-all.

To accomplish the desired results, special fixtures were designed as shown in the illustration. The larger fixtures are used when grinding the surfaces as shown in illustration, and the smaller for grinding one of the edges.

The pieces are first ground wet on a Heald 12" rotary grinder using a 12 x 1

x 5" vitrified Alundum wheel 3830, grade I. About .020" stock is removed, leaving for finishing .001" on the flat side and .005" on the edges.

Finishing is done on a Brown & Sharpe surface grinder No. 2 with an Alundum wheel 7 x $\frac{1}{2}$ x $1\frac{1}{4}$ " 6646-H.

The small fixture shown was designed for the grinding of one edge of the piece which is .031" lower than the other edge.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Publications

Landis Camshaft Grinding Attachment. Machinery, November, 1920, page 292. Developed by the Landis Tool Co., Waynesboro, Pa.

Gardner No. 24 Continuous-Feed Disk Grinding Machine. Machinery, No-

vember, 1920, page 296. The latest development of the Gardner Machine Co., 414 Gardner St., Beloit, Wis., is a continuous-feed disk grinding machine.

[DECEMBER, 1920]

[11]



Badger Vertical-Spindle Disk-Grinding Machine. *Machinery*, November, 1920, page 299. A vertical-spindle disk grinder known as the No. 142 has recently been added to the line of equipment manufactured by the Badger Tool Co., Beloit, Wis.

A Home-Made Surface Grinding Machine. *American Machinist*, October 14, 1920, page 731. Very brief description of a grinding rig made to sharpen small dies.

Cleaning a Grinding Wheel with Gasoline. *American Machinist*, October 14, 1920, page 733.

Self-Contained Motor-Driven Tool-Grinding Machine. *American Machinist*, October 14, 1920, page 739. Brief description of the tool-grinding machine recently placed on the market by the U. S. Tool Co., Cincinnati, Ohio.

Some notes on Knife-Grinding. *Woodworker*, October, 1920, page 28.

Webster & Perks Plain Manufacturing Cylindrical Grinding Machine. *American Machinist*, October 21, 1920, page 785. This machine has been added to the line of the Webster & Perks Tool Co., Springfield, Ohio.

Oakley No. 3 Universal Toolroom Grinding Machine. *American Machinist*, October 21, 1920, page 786. Description of a machine introduced by the Oakley Machine Tool Co., Cincinnati, Ohio.

"Micro" Internal Grinding Machine. *American Machinist*, October 21, 1920, page 788. An account of a machine manufactured by the B. L. Schmidt Co., Davenport, Iowa. The principal features of the machine are the provision made for wet grinding and the semi-automatic operation.

Modern Lapping Practice. *Machinery*,

November, 1920, page 209. An account of the developments in lapping practice, including the abrasives used and lap-charging methods.

Making "Curvex" Milling Cutters. *Machinery*, November, 1920, page 250. Methods and equipment employed by the Pratt & Whitney Co., Hartford, Conn. This article includes a description of the special cutter grinding machine developed for sharpening these cutters.

Webster & Perks Plain Manufacturing Grinding Machine. *Machinery*, November, 1920, page 291. Description of a 6 by 30-inch plain cylindrical grinding machine designed by the Webster & Perks Tool Co., Springfield, Ohio.

Oakley No. 3 Universal Tool-Room Grinding Machine. *Machinery*, November, 1920, page 292. The No. 3 universal tool-room grinder now being manufactured by the Oakley Machine Tool Co., Oakley, Cincinnati, Ohio, has incorporated in its design certain new features intended to insure such essential features as accuracy, rigidity, and convenience of control.

Device for Grinding Clearance Angles on Tools for the Automatic. *American Machinist*, October 7, 1920, page 656.

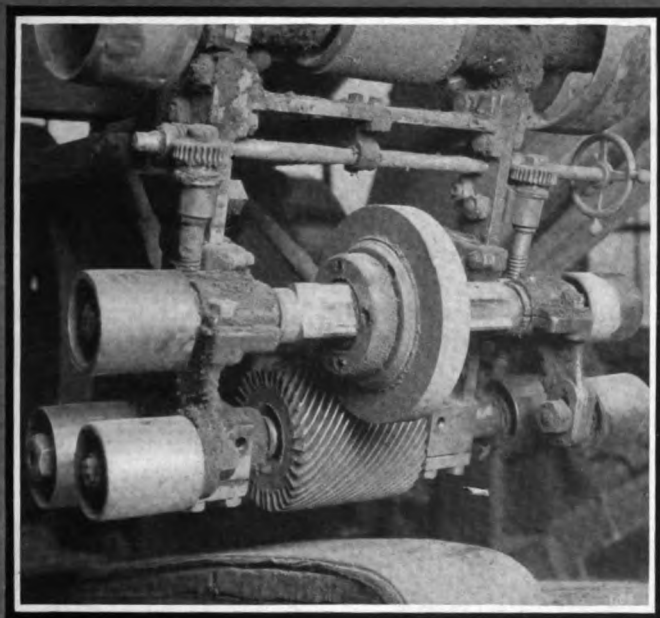
"Commercial" Grinding Wheel Dressers. *American Machinist*, October 7, 1920, page 695. Illustrations and brief mention of three styles of grinding wheel dressers marketed by the Commercial Welding and Machine Co., Worcester, Mass.

Portable Rotary Pneumatic Grinder. *Iron Age*, October 7, 1920, page 906. A pneumatic grinder with but three moving parts is announced by the Roto Pneumatic Co., 4700 Train Avenue, Cleveland.

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GRITS and GRINDS

JANUARY—FEBRUARY
1921



Abrasives in the
Leather Industry



Grits and Grinds

Vol. XII January—February 1921 No. 9

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Abrasives in the Leather Industry

By C. H. BAKER, JR., AND R. H. CANNON

Norton grinding wheels are supplied in large quantities to tanneries, belting shops, leather specialty shops, and glove manufacturers. Leather is too expensive to waste and must therefore be cut and shaved with sharp knives and cutters if economical results are to be obtained. The best wheels for this work are easily determined because their efficiency can be accurately measured.

The machines with operations where grinding wheels and polishing grain are used may be listed as:

- (1) Dehairing machines
- (2) Fleshing machines
- (3) Shaving or whitening machines
- (4) Buffing machines
- (5) Splitting machines
- (6) Skiving machines
- (7) Drums and buffing wheels in the glove industry

Dehairing Machines

The dehairing machine has a large spiral cutter, about 6 to 8' long and 8 to 10" in diameter. The cutting blades as shown in figure 1 are like those of a lawn mower and operate in much the same way. The hide, hair side up, is laid on a canvas which is suspended loosely between bars. The cutter, carried by two long arms, is then passed over the hide and the hair is pulled out and cut off as the cutter revolves at a high rate of speed. The hide has first been soaked in water for from two

to six days and in a solution of lye for about the same time. There are usually two sets of machines, one each for the first and second dehairing operations. The cutters of the first machine are sharpened by filing.

The grinding operation which is on the second machine is performed by a brick usually 2 x 3 x 8"—24-R Alundum vitrified. This sharpening is done offhand.

Fleshing Machines

The fleshing machine resembles the dehairing machine somewhat though the long spiral cutter is stationary and does not move up and down.

The action of the dehairing machine is more pulling than cutting. On the fleshing machine the blades of the cutters are closer together and must be kept sharper. They actually cut and scrape the flesh from the raw hides before tanning. Sharpening on fleshing-machine cutters is done by a brick just as on the dehairing machine except that here it is held in a fixture and traversed on top of the cutters by means of parallel ways as illustrated in figure 2. The usual grain and grade is 24-R Alundum vitrified, though we sometimes find 46-O being used.

Shaving Machines

The leather is shaved or "whitened" after tanning, the purpose being to remove the scale and smooth the flesh side.

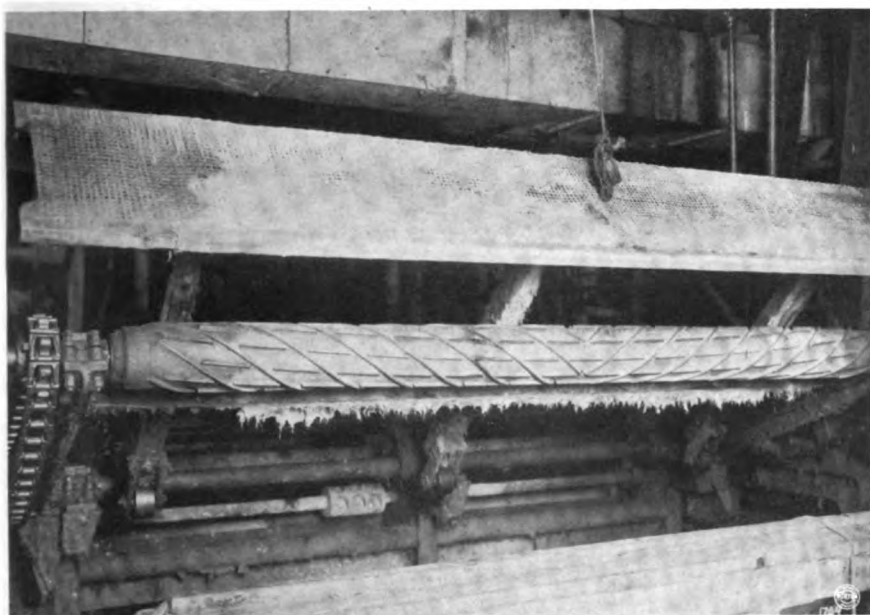


Fig. 1. Dehairing Machine Used in a Tannery

The spiral cutters are about 7" long and 6" in diameter with blades $\frac{3}{4}$ " apart. The wheel is in constant contact with them, traversing automatically. The cutter on the Freeman machine is shown on front cover. It passes rapidly back and forth over the leather as it revolves and the hide is moved under it by hand. Wheels used for this work are 9 x $1\frac{1}{4}$ x 4" grain 6650 grade O or P. It is vitally important that wheels be in as nearly perfect balance as possible.

Buffing Machines

Buffing is much like shaving except that it is more of a finishing operation. The skins are always dry. The cutters resemble those on shaving machines but the blades are closer together and lighter. The size is 9 x $1\frac{1}{4}$ x 4". Here again the wheel is in constant contact with the cutters, traversing automatically. It

rests lightly on the cutters, and wheel and cutter wear is much less than would be supposed. The usual grain and grade is 6680-N, while one customer uses as fine as 66100 grit in grade 5 elastic process. Buffing is also done by hand with a special scraping knife resembling an old-fashioned hand meat chopper. These are sharpened on India oilstones.

Splitting Machines

The splitting machine contains an endless knife which passes over two large wheels the same as a band saw. The leather in the full width of the hide passes through rollers toward this knife which is travelling at a high rate of speed. Adjustments of the knife and the guide are such that a limit of 1-128" can be adhered to. As the knife passes along the bottom, it goes between two grinding wheels which are adjusted to grind the proper bevel and

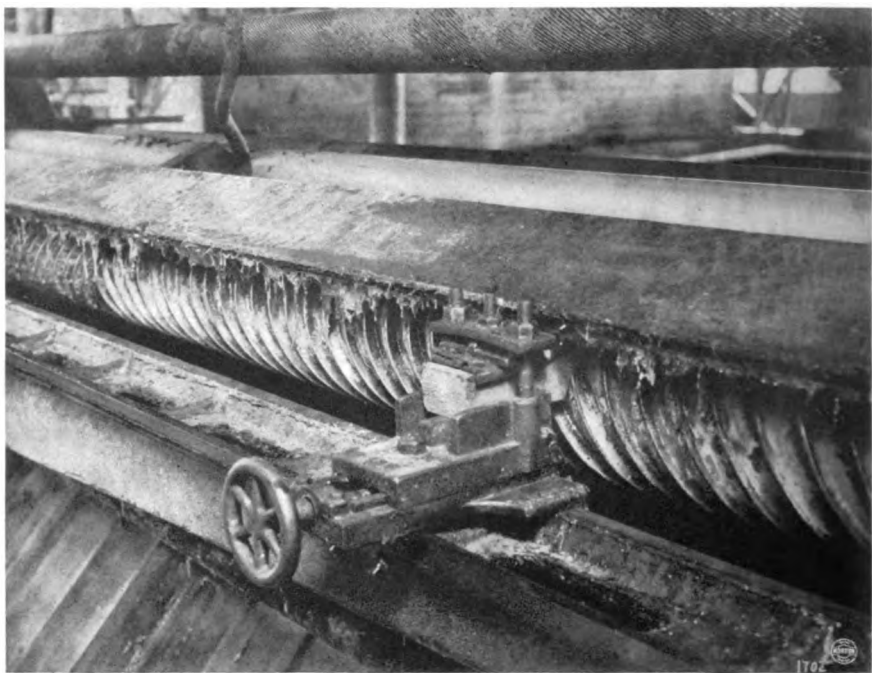


Fig. 2. Fleshing Machine Showing Method of Sharpening Cutters with an Alundum Brick

keep a keen edge on the knife every minute. Figure 3 shows the method employed by the Turner splitting machine. The most common wheel is 10 x $\frac{3}{4}$ x 1" grain 6630 grade 1½ elastic. Some skins with special treatment have more or less pumice imbedded in them which tends to dull the knife. This is especially true of sheep or colt skin for gloves. Skins of this kind and also those which are split dry are hardest on the knife. Wet splitting is naturally easier and the wheels can be adjusted for a lighter cut. The knife should last about three or four weeks for wet and about two weeks for dry splitting. The arrow in the photograph shows the location of the knife.

Skiving Machines

Skiving or "Pointing" machines are used in the belting industry. In order to

cement several strips of leather together they must be bevelled for a long splice. The very tip of each piece must be made very thin in order to have the belt smooth. The first beveling is done by laying the end of the strip of leather in a machine similar to a planer. The knife is stationary and comes in contact with the bottom of the leather. A roller keeps the leather down on the blade and assists the man in pulling it out.

The Fortuna skiving machine has a circular knife, about 4½" in diameter, on a horizontal axis. It takes a cut cross-wise of the strip of leather at the very end. The cutter is bevelled on the outside and is kept sharp by a wheel 2¼ x ¼ x 5", 3880-I. The wheel which is directly underneath can be brought in contact with the knife at any time by pressing a small lever. It helps greatly in getting a keen

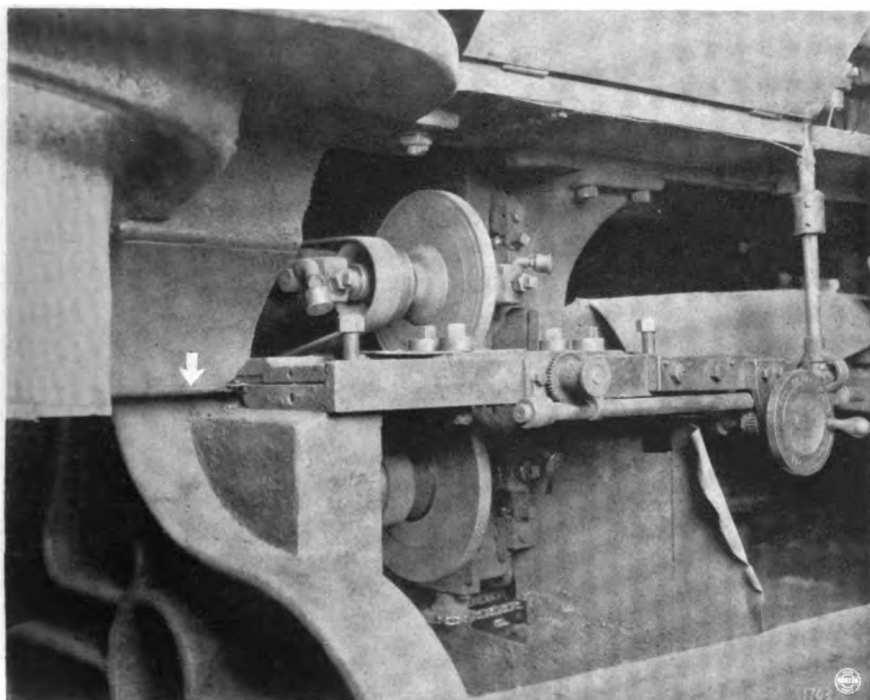


Fig. 3. Method of Grinding Endless Knife on the Turner Splitting Machine

edge on this knife to touch up the inside of the edge with a small half-round India oilstone stick about $\frac{3}{8} \times \frac{3}{4} \times 4''$. These sticks are made in coarse, medium, and fine grit. Fine should be specified. Another wheel of coarse grain acts as a feeder to push the leather under the knife. It is $1\frac{1}{4}''$ in diameter by $1\frac{1}{2}''$ thick and rounded at the ends. The grade is not important as it does no grinding.

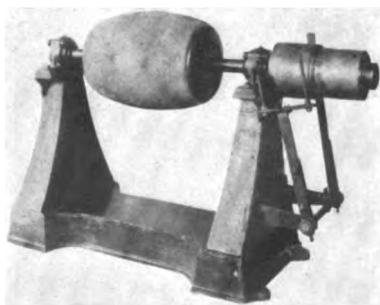
Suede Drums

Crystolon drums for finishing suede leather are 16" in diameter at the middle, tapering to 15" at the end and are 18" thick. The grain and grade is 46 or 60 grade M or N Crystolon. See figure 4.

Another method of finishing suede leather is with Alundum grain on a polish-

ing wheel using several different grain sizes. Starting with 46 or 60, grains as fine as 100 to 180 and even 200 are used.

The wheel is 30 x 8" of wood or compressed paper and the face is rounded.



Crystolon Drum for finishing skins

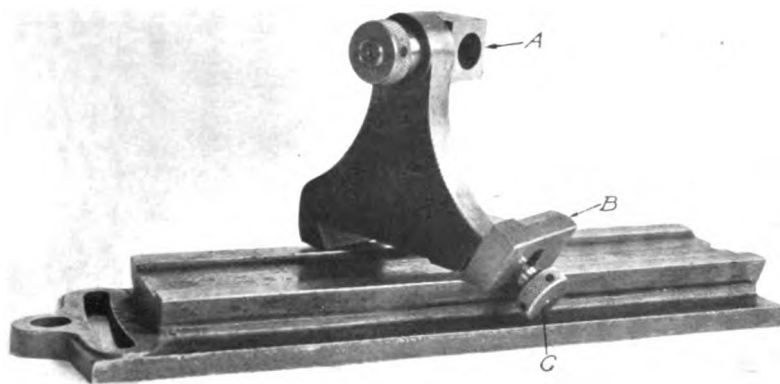


Fig. 2

be placed somewhere near the middle of the table. The special attachment can be adjusted by simply raising the lug at B, then lowering it and tightening the thumb screw at C.

The advantage of such device will be realized when it is remembered that in

grinding a reamer, for instance, the alignment has to be as nearly perfect as possible. If it is necessary to remove the headstock to true the wheel, the operator will have to make his careful adjustment all over again before resuming his work.

The Alundum Wheel in Electric Car Track Grinding

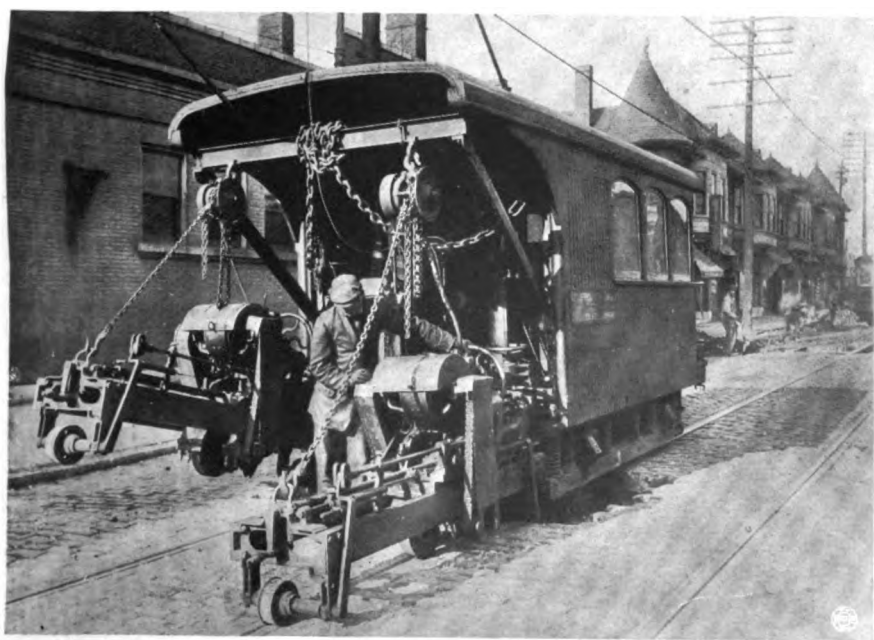
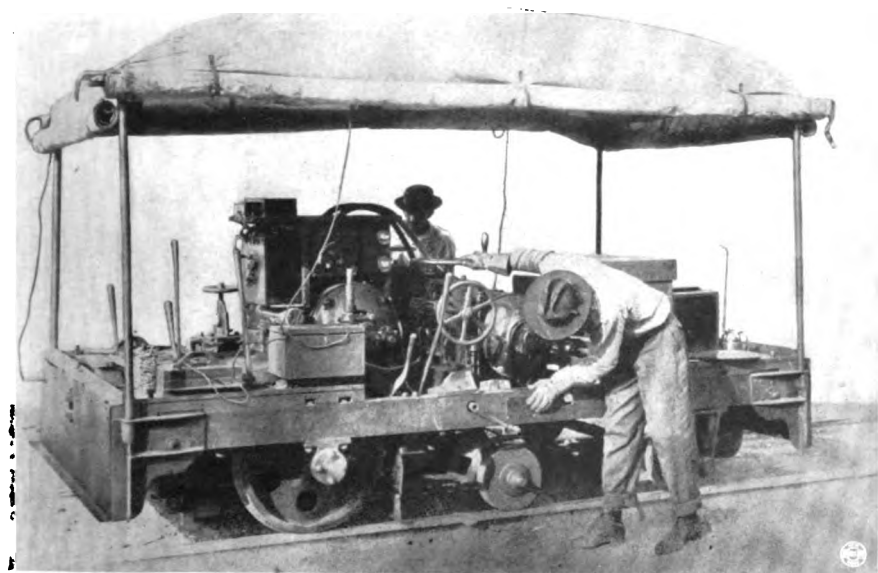
New car rails are welded for purposes of conduction while old ones are welded in repair work. In either case the grinding wheel is necessary to insure smooth riding and to form the joint or repaired rail to the proper shape for the tread of the car wheel. With the modern improved welding and grinding methods, it is possible to repair broken rails and those which are worn excessively where otherwise it would be necessary to scrap them and replace with new ones. An enormous saving of material is thereby effected.

Machines are recommended which have a lot of weight directly over the wheel. This does away with vibration and chattering.

Four different types of electric car-rail grinders are shown herewith. They vary from the light machine which can be carried off the track by hand to the heavy type which is propelled by its own power.

The most common wheel for this work is 16 x 3 x 1½", grain 14 grade R Alundum vitrified.







[10]

[JANUARY, 1921]



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that have Appeared in Recent Publications

Device for Grinding Hacksaws. *American Machinist*, November 18, 1920, page 955.

Changing a Straight-Faced Grinding Wheel to a Cup Wheel. *American Machinist*, November 18, 1920, page 956.

Franklin Transmission Case. *American Machinist*, November 25, 1920, page 1001. Machining the transmission case cover, begins with grinding the bottom surface on a Blanchard machine. An illustration shows the type of clamp used, it being necessary to have the clamp bite into the edge of the plate in order to hold it with sufficient firmness and, at the same time, keep the clamping jaw out of the way of the grinding wheel.

Device for Handling Piston Rings in the Side Grinding Operation. *American Machinist*, November 25, 1920, page 1006. Description of a device which has been developed by the Heald Machine Co. to be applied to its machines in order to make accurate centering a positive operation. It is claimed that the machines can be operated continuously from the start by green operators, for nothing is left to the operator's skill or judgment.

Thread Grinding Wheel Truing Device. *Machinery*, December, 1920, page 323. Very brief description of a thread milling attachment which has been adapted for the performance of a thread grinding operation in the shops of the H. E. Harris Engineering Co., Bridgeport, Conn.

Grinding Wheel Spindles. *Machinery*, December, 1920, page 374.

Chuck for Internal Grinding. *Machinery*, December, 1920, page 377. Description of a device permitting the rapid and accurate chucking of such work as bushings, circular cutters, hobs, etc., for internal grinding.

Dawsearl Finger Abrasive Wheels. *Machinery*, December, 1920, page 389. The Dawsearl Tool & Machine Co., 390 Forest Street, Arlington, N. J., has recently developed a line of small abrasive "finger" wheels, which are especially adapted for resharpening button dies and for grinding small-diameter bushings, drawing dies, etc.

Setting Diamonds for Truing Grinding Wheels. *American Machinist*, December 9, 1920, page 1092.

Device for Grinding Engraving Tools. *American Machinist*, December 9, 1920, page 1096. This device was designed by Mr. Rhodes of the S. A. Rhodes Mfg. Co., Chicago, Ill.

Grinding Cast Iron Wheels. *Railway and Locomotive Engineering*, December, 1920, page 345. An account of the practice in the shops of the Atchison, Topeka & Santa Fe R. R. Detailed information is given in regard to the investigation which was made to determine the probable depth of chill. Five tables of measurements are given. "The machine used is one that represents the latest development in car wheel grinding machines and is manufactured by the Norton Co. of Worcester, Mass."



A Few Points on Grinding *Worth Remembering*

BY CHARLES H. NORTON

Relatively hard wheels are used for soft material and for small work, and softer wheels for larger work and harder material. The reverse is true if one speed of work only is used and the same amount of material is removed in the same time.

The harder the material being ground the softer the wheel should be, or the faster the work surface, or both.

The softer the material being ground the harder the wheel should be, or the slower the work surface, or both.

The larger the work the softer the wheel should be, or the faster the work surface, or both.

The smaller the work the harder the wheel should be, or the slower the work surface, or both.

The larger the work the longer the arc of contact between work and wheel.

To counteract the effect of longer arc of contact the surface speed of the work must be increased. In fact the cutting action of the wheel can be controlled entirely by the work speeds.

The slower the work revolution and the softer the wheel, the deeper the cut may be, and with this combination the maximum amount of metal can be removed in the minimum time with the minimum loss of wheel and minimum consumption of power.

Relatively fast work revolution with soft wheel causes the wheel to wear away rapidly.

The faster the work revolution the harder the wheel must be, whether roughing or finishing.

The slower the work revolution the softer the wheel must be, whether roughing or finishing.

Slow work revolution, hard wheel, and deep cut cause the wheel face to load with steel, preventing the wheel from cutting.

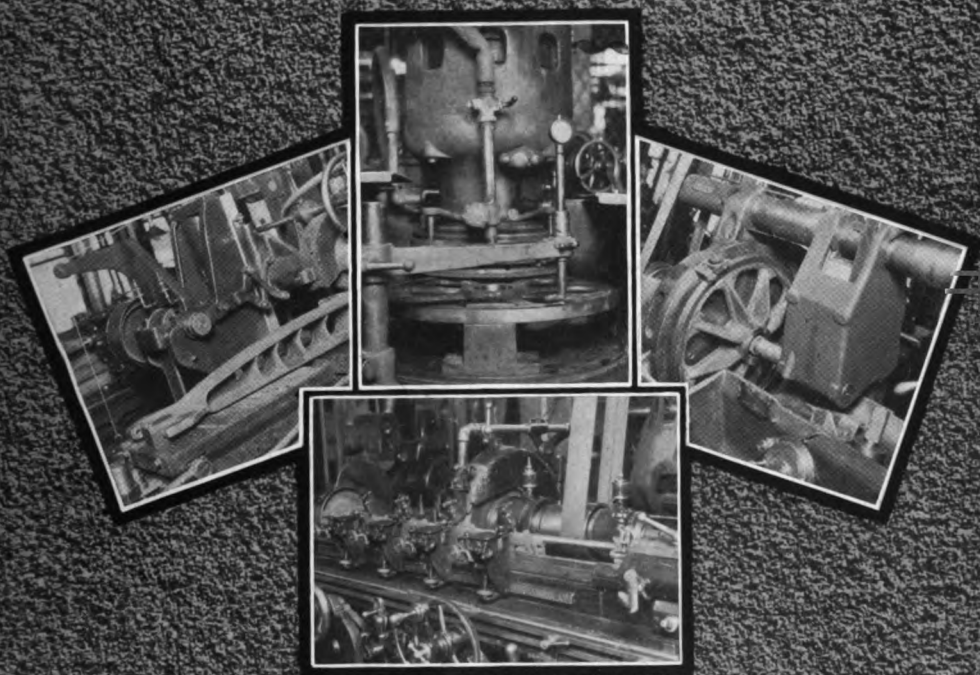
Slow work revolution and hard wheel with light cut cause the wheel to glaze, preventing the wheel from cutting.

By the use of the variable work speeds of grinding machines we can use on small, hard material the wheels graded for large, soft material and vice versa.

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GRITS and GRINDS

MARCH-APRIL, 1921



Various methods of grinding
are employed in the production
of a gear shaper



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Grinding Operations in the Manufacture of the Fellows Gear Shaper

By R. H. CANNON

A gear shaper is no more accurate than its cutter, its cutter arbor, cutter guide, its work spindle, or any one of a dozen other vital parts. Few machine tools demand such extreme accuracy as the gear shaper and gear-shaper cutter. There must be no misshapen teeth or poorly fitting parts if gears are to be cut to run smoothly, silently, and with maximum efficiency.

At the plant of the Fellows Gear Shaper Company, Springfield, Vt., accuracy is the watchword. Their limits are so close that they can be adhered to only by precision grinding.

In the manufacture of one type of Fellows gear shaper there are 226 separate grinding set-ups, some of which include the grinding of several diameters on one piece. Out of this list we have picked a few of the most interesting operations. They are representative of the vast amount of grinding done and serve to illustrate that there are hundreds of delicately adjusted machine tools which would be impossible without the grinding wheel.

The gear-shaper cutters are ground all over after hardening, so that the heat treater knows he is unhampered and that distortions will be ground out, finishing the cutter correctly in every detail.

The operation on which all the others depend in the grinding of the gear-shaper

cutter is that of surfacing the back. This surface must be absolutely flat and true, for not only does it serve as a bearing when grinding the face, the hole, and between the teeth, but when the cutter is in actual operation on the gear shaper it must lie absolutely flat against the spindle flange in order to cut correctly.

The back of the cutter is ground on the Person-Arter rotary surface grinder, using a wheel 12 x 1 x 5" grain 6636 grade J, Alundum vitrified. The face is ground on the same machine with the same wheel, the chuck being set at an angle of 5° from the horizontal to give the proper clearance angle. The wheel is fed back and forth to the center of the cutter automatically. The latter set-up is one that can be used for resharpener also.

The cutter is then placed in a chuck with the back fitting against another perfectly true and flat surface, and the hole is ground to exact size on the Bryant internal grinding machine. Here the fit must be within 0.0001", or in other words, as nearly perfect as the workman can get it by means of a standard plug gauge and a delicate touch. The wheels are 3860-J for roughing, and 3890-K for finishing. Both are mounted on the same spindle, as shown in the illustration, so that only one set-up is necessary. After roughing, the table dogs are simply set farther along so that the traverse is past the finishing wheel only. This method is possible in



Figure 1

grinding holes in thin pieces where the traverse is short. The operation is illustrated in figure 1. Experiment on this job proved beyond question that the grinding method produces a hole which is more accurate and more satisfactory as to finish than a lapped one.

Grinding between the teeth of the cutter is done on a special machine which is a marvel of design and of accuracy of performance. The cutter is made to roll down onto the grinding wheel in such a way as to produce a true involute curve on the side of each tooth.

Figure 2 shows the grinding of the horizontal feed rod on the Norton 10 x 50" plain grinding machine. This part is 1" in diameter by 50 $\frac{3}{4}$ " long and requires the careful use of steadyrests to produce a finished rod of uniform diameter. The wheel used is 18 x 2 x 5" grain 6624 combination grade J Alundum. The work is revolved at 47 r. p. m. and the wheel at

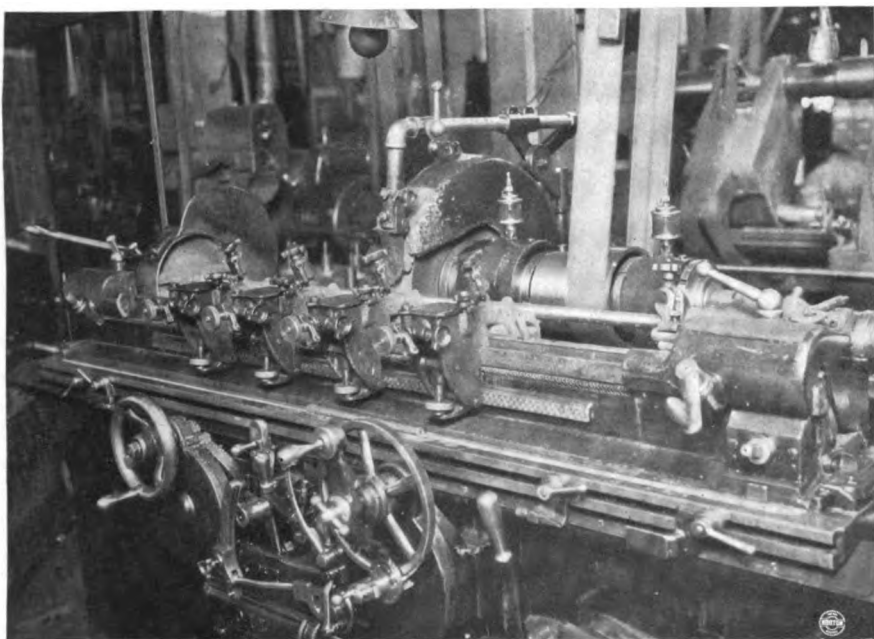


Figure 2

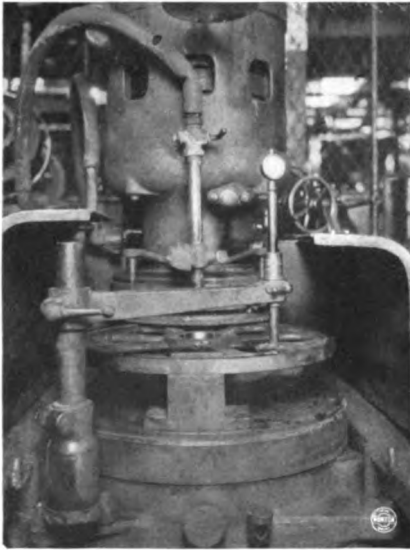


Figure 3

5,500 s. f. p. m. Production is three completed pieces per hour, 0.030" of stock being removed.

Figure 3 shows the surfacing of the upper face of the lower index wheel on a Blanchard surface grinding machine, using a wheel 18 x 5", 1½" rim, grain 20 grade H Crystolon. The material is cast iron. It is necessary to remove 0.010" to 0.015" from the rim and hub on each side. From the operation shown in the photograph, all subsequent machining operations are located. For instance, figure 4 shows the Bryant internal grinding machine finishing the hole in the same part. The hole must be true and perpendicular to the rim, which is shown against the chuck. The hole is 4½" long and 3⅞" in diameter. The amount of stock removed is 0.015", the wheel being 3 x ¾ x ⅞", countersunk one side 1¼ x ¼", 24-J Crystolon. Three holes per hour are completed.

Another Blanchard surfacing operation, that of siding cast-iron change gears, is shown in figure 5. Both sides are finished from the rough without any other

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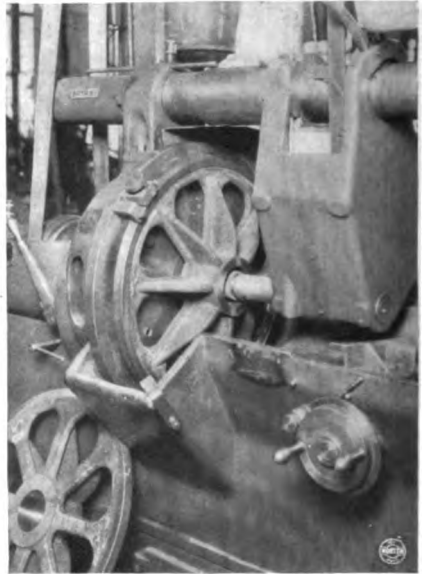


Figure 4

machining operation, the pattern having been made so that only ⅜" of material is left for finishing. The same wheel,

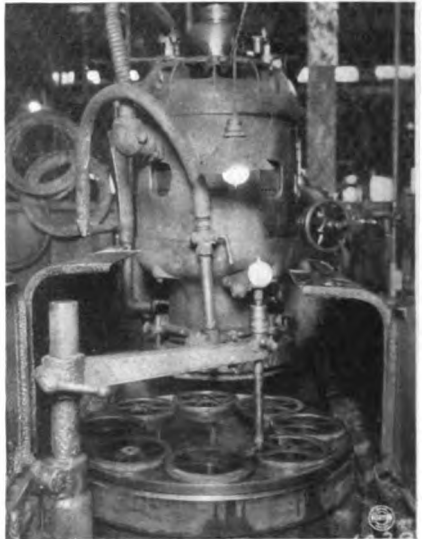


Figure 5

[MARCH-APRIL, 1921]



The cutter spindle shown in figure 6 is also ground cylindrically on the Norton 10 x 50" plain grinding machine, where



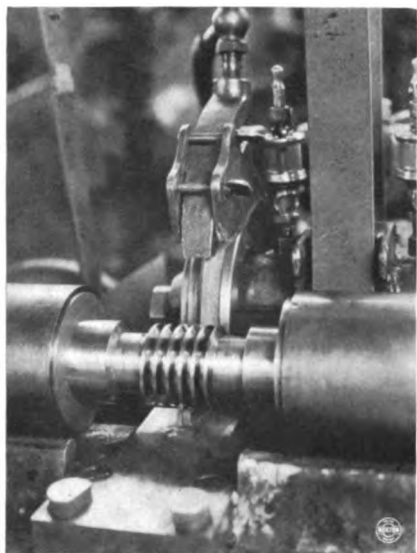


Figure 8

six different diameters are brought to size, removing an average of 0.015" to 0.020" of stock and leaving a good commercial finish. The wheel used in this work is 18 x 2 x 5" grain 6624 combination grade K Alundum vitrified. The cylindrical work on one of these spindles is completed in about 30 minutes.

Figure 7 shows a surfacing job on the Diamond machine. This part is called the apron lever. The ends of the bearing have to be ground square with the hole, about 0.010" of stock being removed from each side. Production is kept at the rate of three pieces per hour in spite of a close limit of 0.0005". The wheel is 12 x 1½ x 1½" 3824-K Alundum vitrified, running at 1,800 r. p. m. and with a table traverse of 40 feet per minute.

Figure 8 shows a nice job of grinding between the threads of a worm gear. This is done on a special machine, using a wheel 8½ x ½ x 5" grain 6660 grade K Alundum vitrified, dressed to a thin edge.



Figure 9



The job requires a good finish. It is possible, by grinding the threads of this worm gear just as in thread gauge work, to get true threads in a much shorter time than by lapping.

Another operation on the worm gear is cylindrical grinding on a Norton plain grinding machine with an 18 x 2 x 5" grain 6624 combination grade K Alundum vitrified wheel. It must be perfectly round with no taper whatever and the tolerance on the diameter is plus 0.000" and minus 0.00025".

The ends of the same part are surfaced on the Persons-Arter rotary surface grinding machine, using a wheel 12 x 1 x 5" 3836-I. The tolerance is 0.002", but the ends must be exactly perpendicular to the axis. Six or seven per hour are completed.

The top of the saddle rail on the base of the machine was formerly scraped to make a perfect bearing. It was thought that grinding would do the job in a much shorter time if suitable equipment could be obtained. A special fixture was

devised, as illustrated in figure 9, which is located from the ways of the bed and on which the special grinding machine head is pushed along by hand. The wheel is fed transversely just as on any ordinary surfacing machine. Thus a precision operation is performed by a portable grinding machine. The wheel used is 8 x 1/2 x 1 1/2" grain 46 grade J regular Alundum. The surface obtained is as satisfactory as could be obtained by endless scraping, and a great deal of time is saved.

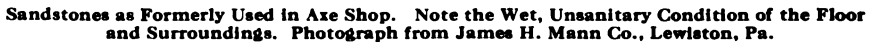
The work spindle is ground externally, internally in both straight and tapered holes, and is faced on the end. It is practically ground all over. Pulleys are crowned on the Norton cylindrical machine using a 24-I Crystolon wheel. There are dozens of other grinding operations in this up-to-date shop, but space does not permit a description of each one. Suffice it to say that grinding is depended on to produce accuracy and low cost wherever possible and a close study of the subject has been made by those in charge.

Sandstone Replacements

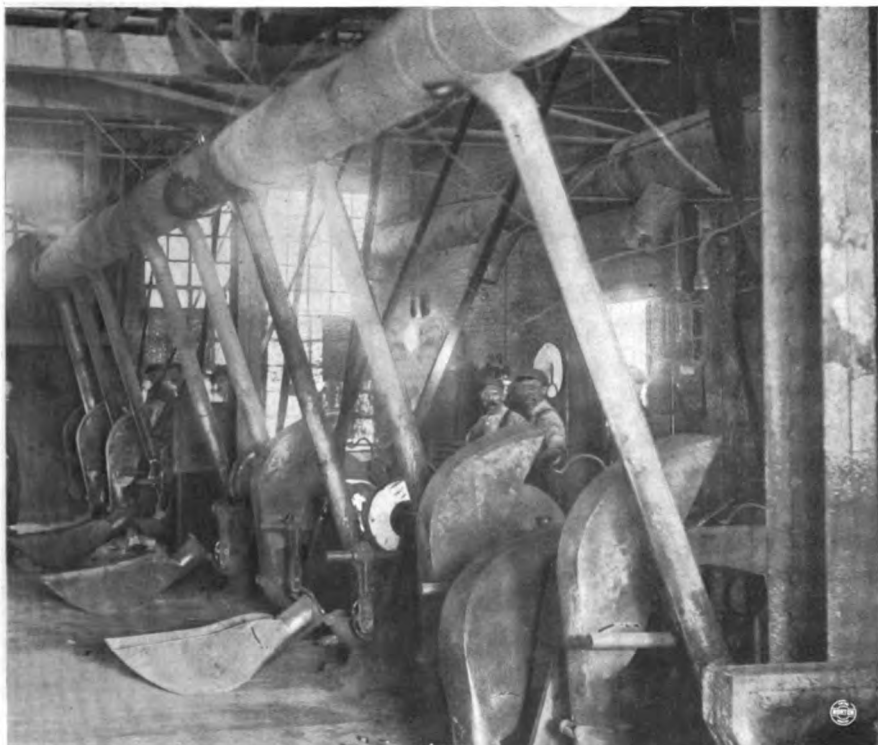
By W. W. GREENWOOD

Sandstones, because of certain characteristics, have been employed for a number of grinding operations in which there is danger of burning or drawing the temper of the work. - The abrasive (sand) in these natural stones is soft and breaks down easily when compared with the various artificial abrasives. The cementing material (bond) is also easily fractured when submitted to grinding conditions. Hence sandstones are cool cutting and fast wearing. Having such a structure, they absorb and readily hold the water used for lubrication, and this factor tends to keep the temperature of the work being ground fairly uniform. Because of these properties in grinding such products as cutlery, hatchets, axes or section knives, sandstones for a time had a field which was all their own.

These somewhat rigid requirements are being met one by one by artificial grinding wheels, the reasons for this being that while the structure of a sandstone is not capable of undergoing modification, the manufacture of a grinding wheel is under control and can be readily adapted to external conditions. Geologically, sandstones are composed of grains of sand deposited and bonded together by the action of water in ages past and they often contain seams or hard and soft spots like other rocks. Different stones from the same quarry vary in hardness and therefore grinding conditions in a shop where they are employed cannot be standardized very well on a production basis. Compare a means of grinding having these limitations with the modern grinding wheel and what is most obvious?



Artificial wheels have a longer wheel life, the same size wheel often being found producing from 10 to 15 times as much work as a sandstone. Because of this slower wear, in form grinding they hold any special shape of face better. In contrast to the sandstone, the use of artificial wheels does not affect the lungs of the workman. In a report of the United States Public Health Service, "A Study of the Dust Hazard in the Wet and Dry Grinding Shops of an Axe Factory" (Public Health Reports, October 8, 1920, pages 2393-2401), Dr. Winslow has shown the danger present to health in a factory where sandstones are used for grinding. In one of his conclusions he states, "It is evident that wet grinding on sandstone wheels, as practiced at the axe factory studied, is an exceedingly hazardous process, and that the substitu-



Alumund Wheels have Replaced Sandstones in the Room Shown on Opposite Page.
Note the Dust Exhaust System and Better Working Atmosphere.
 Photograph from James H. Mann Co., Lewiston, Pa.

tion of dry grinding with an efficient exhaust system (or possibly the use of wet grinding on artificial abrasive wheels of a harder nature) is clearly indicated as a measure for the protection of the workers against respiratory disease." The illustration showing the racing of one of these stones gives an idea of the unhealthy atmosphere which their use produces. This fine dust is so uncomfortable as to cause other employees to leave the room during the operation. The grinding wheel abolishes such conditions.

An account of a number of operations in which sandstones are being replaced will perhaps be of interest.

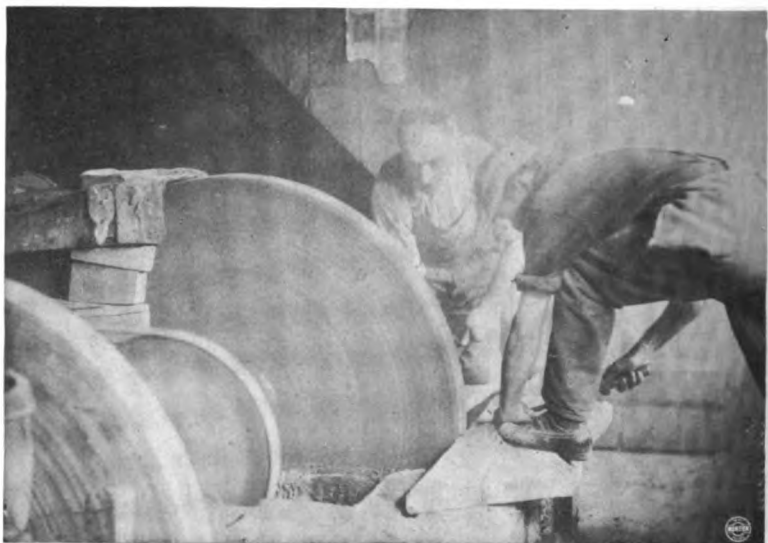
Grinding Hammers

Generally speaking, there are two classes of hammers—claw and machinists'. The operations performed on claw hammers

may be roughly grouped as grinding the sides, back and face; grinding under the claws; and grinding the slits between the claws. The side of the claw is concave, the radius of curvature being about 24", so that when a 48" sandstone is used, its periphery is practically correct for grinding this concavity. With a 30" artificial wheel the work must be rocked slightly in order to grind all over. Special jigs and holders are used on artificial wheels which overcome all handicaps from the smaller arc of contact.

Axe and Hatchet Grinding

Axes are ground soft as they come from forging, the amount of material removed depending a good deal upon the shape of the axe, the condition of the dies, and the workman. Siding is usually done with a so called pony or saddle, the pressure



Showing Condition of Room While Racing a Sandstone

being obtained by the operator's weight. The usual method of holding the axe is to insert a stick through the eye, which enables the operator to manipulate the work without handling the hot pieces. Artificial wheels most generally employed are 24 x 4", tapered both sides $\frac{3}{4}$ " per foot.

The methods of finishing axes vary considerably in different shops. In some cases they are simply tempered after the rough grinding and then polished. Another method is to rough grind the forging and rough polish on a leather polishing wheel mounted with No. 46 Alundum grain. This removes the blue finish from grinding and smooths the deep lines left by the grinding wheel, so that polishing after hardening is made easier.

Edging of hatchets and axes is done with a wheel 24" in diameter, either 30 or 36 grade S Alundum vitrified.

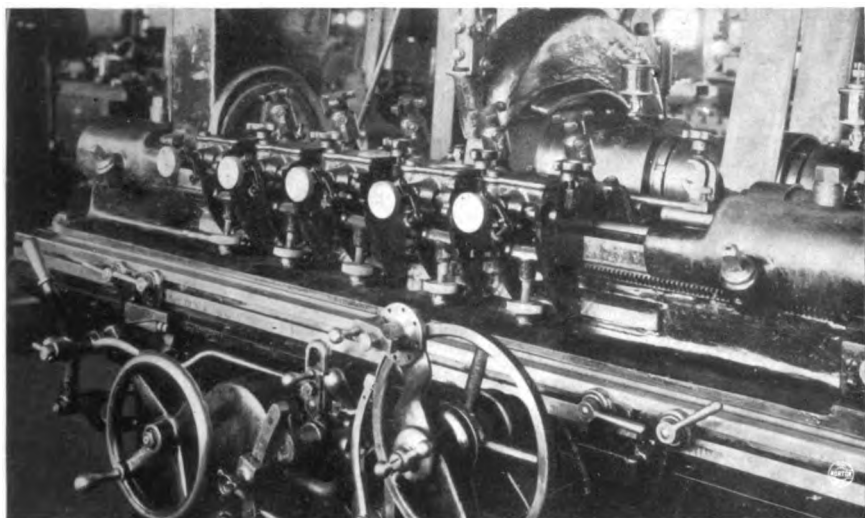
Pocket Knives

In pocket knife grinding, Alundum silicate wheels in sizes up to 60" are employed. This work may be done automatically on Hemming machines taking cylin-

ders 14 x 3 $\frac{1}{4}$ " with $\frac{5}{8}$ " rim. Squaring the tang requires a 12 x 1 $\frac{1}{2}$ x 1 $\frac{1}{4}$ " Alundum vitrified, and the front edge of the tang also takes a 12" diameter vitrified wheel, 1 to 2 $\frac{1}{2}$ " thick. For cholling, use a 12 x $\frac{1}{4}$ x $\frac{1}{8}$ " (bevel face) Alundum rubber; for edging, a 10 x 1 x 1" fine Alundum vitrified. The hand grinding of table-knife blades on large stones has been practically eliminated — the automatic grinding machine manufactured by Hemming Brothers, New Haven, Conn., having replaced this operation. An Alundum cylinder 14 x 3 $\frac{1}{2}$ ", 1 $\frac{1}{4}$ " rim, made by the elastic process, is used. The bolster is sometimes ground with a straight wheel 24 or 30 Alundum rubber. The neck is hand ground, using a form wheel $\frac{3}{4}$ to 1" thick in grain sizes 46 to 60 grade L or N Alundum vitrified.

Grinding Shears

The illustration above shows an off-hand grinding operation on shears. The wheels used for work of this nature are large Alundum silicate 48 x 3". For edging and pointing, smaller wheels, 12 x 1 $\frac{1}{2}$ " Alundum vitrified, are used. The same holds true in grinding the heel



end of shears, except that a 26" diameter wheel is most commonly taken. The backs of blades are also ground with the same size Alundum silicate wheel.

In the manufacture of files, grinding follows the annealing process. It is necessary in order to remove the outside scale of the annealed blank. After thorough heat treatment, a piece of tool steel cannot be hardened until a hundredth of an inch or so is taken from the blackened surface. In shop parlance, the carbon has been burned off the surface; and if a single black spot is left, a soft tooth will result. It is to remove this skin of decarbonized material and also to produce a smooth surface (the face of the file may have been slightly bruised during the operation) that grinding is employed.

Grinding is important in the manufacture of augers and bits from the time these tools leave the drop forge. For grinding the cutting surface (this is the surface which works after the screw has sunk so deep that the lips can bite into

the work) Alundum rubber wheels of 36 or 46 grain are used. After the preliminary grinding process, bits are hardened and tempered. This heat treatment may bring about a slight warping, a condition which is remedied by subsequent grinding operations. Off-hand grinding of the twist is also done with rubber wheels.

There has been some prejudice on the part of operators to using artificial wheels on saws, because at the start they have to be more careful about burning their work than with a sandstone. As soon as they realize, however, that the artificial wheel cuts faster and it is therefore not necessary to exert so much pressure on the work, results are very satisfactory. For off-hand grinding of hand saws large Alundum silicate wheels 36 to 48" diameter are employed. Both sides of circular saws are ground at the same time by using a specially designed machine

mounting a pair of 18 x 6" cup wheels, having a 1½" rim.

Miscellaneous Operations on Knives

For surfacing the steel backs of section knives, 30 x 6" Alundum silicate wheels are successful. These knives are sharpened with similar wheels in slightly harder grades.

In surfacing hardened steel knives used for cutting nails, large Alundum silicate wheels are doing good work.

Some manufacturers of barker and chipper knives employ silicate cylinders 24 x 4, 3" rim for the finishing operations.

Spindle Grinding

In the grinding of spindles for silk and cotton mills, the advent of the grinding wheel in conjunction with modern grinding machines has brought about an increase in production over that obtained with the sandstone. The material comes in the bar form or forged, .015" to .020" oversize. Very little turning is done and practically all spindles are ground, the grinding generally being performed in two operations, roughing and finishing.

Production figures indicate that there is a saving of about one third in the time of grinding each spindle by using artificial wheels. This saving more than compensates for the increased first cost of the wheel as compared with the sandstone.

Spindle Rolls

Where sandstones (Hindustan bricks) were formerly employed in the stoning operation on spindle rolls, Alundum silicate bricks are now used in some shops. They remove burrs left on the back of the flute by machining, give the same smooth finish that is so necessary to prevent splitting the cotton thread, and have about twice the life of the natural brick.

Optical Work

Not so long ago, ordinary sandstones were used universally in the optical industry. Then the Craigleth stone, which is of natural origin like the sandstone, only finer and harder, was substituted. But even such fine stones were subject to the same objections which apply to all natural products, and they have been replaced in many cases by the Alundum lens grinding wheel. These run from 10 to 24" in diameter, and from 1 to 2" thick, Alundum vitrified. Optical work, much more than many types of grinding, requires that a wheel stay in



Using Alundum Wheels for Grinding Shears

truth and that its face be free from holes and soft spots—qualities which artificial wheels possess.

Cut Glass

There are many shapes and varieties of Norton wheels that have replaced natural stones in the cut-glass industry. They produce a clean sharp cut, because the miter stands up from three to five times as long as was formerly the case.

Norton deep miter stones are employed on punties, scallops and beading. For medium miter cuts, fans, flower stems, the Norton medium miter stone has been found to be very fast cutting and altogether desirable. Small fine multiple or gang miters are best done with a fine miter stone, since it is particularly designed for holding the miter well; this type of stone is also furnished in sizes for stone engraving. In work on light ware (tumblers) and flat miter cuts such as leaves and edge work, or in fact for all classes of work where an especially smooth stone is not essential, the Norton light-ware stone is recommended.

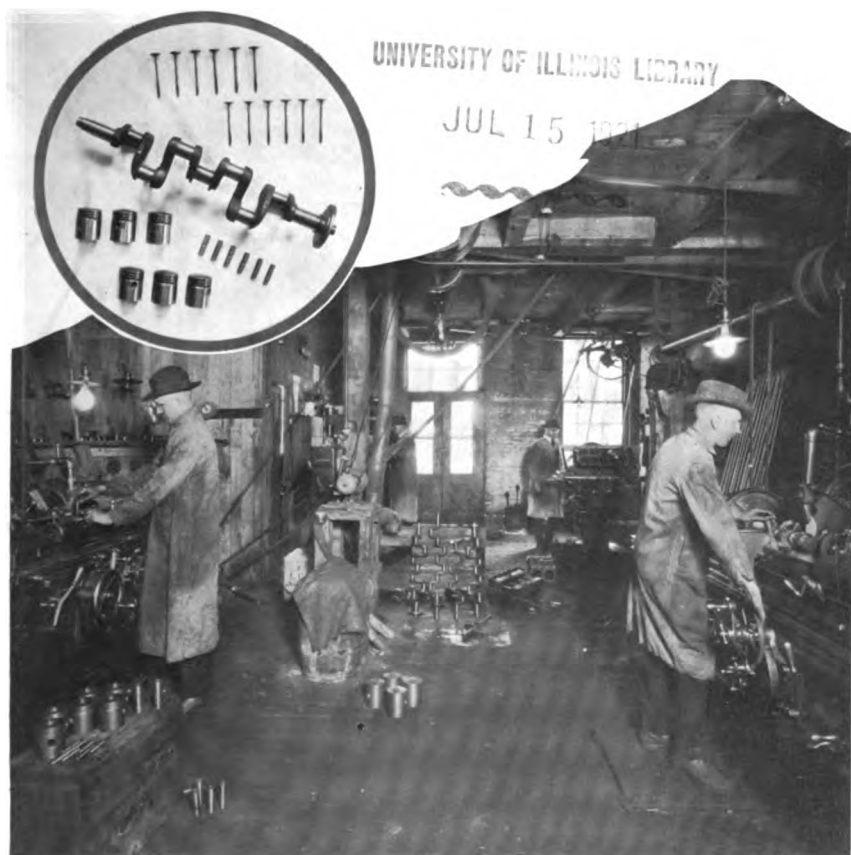
There are a number of other industries where sandstones are employed in which grinding conditions could undoubtedly be bettered by using artificial wheels. Perhaps the suggestions in the article prompt a desire for experiments in this direction.

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GRITS and GRINDS

May-June

1921



A typical shop where used automobile engines are renewed by regrounding crankshafts, valves, and the cylinder bore, fitting with oversize pistons ground to fit the cylinders, and new piston pins. Photograph made in the shop of the Worcester Grinding Company, Worcester, Mass.



Grits and Grinds

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A New Industry

Regrinding Automobile Engine Parts

BY GREGORY BROWN

The business of manufacturing automobiles has upset all precedents by becoming in the short space of twenty years one of the largest manufacturing industries in the United States. There are now in use in this country approximately ten million motor cars and trucks, and considerably over a million new cars are being put into use every year, to say nothing of the constantly increasing output of tractors.

It will be seen from the above figures that at the present time the number of cars in use is about ten times the number of cars that are produced each year, and the business of repairing and maintaining this enormous number of cars bids fair to rival in importance the business of manufacturing new cars.

A recent and interesting development in the repair business has been the renewing of old engines by the regrinding process.

It is obvious that the engine, being the source of power and containing so many revolving and reciprocating parts, is subject to greater wear than any other portion of the car. If it were possible to renew the engine the car would have at least twice the life it now has.

Furthermore, this result can be obtained at a fraction of the cost of a new

car, even assuming a liberal return value of the old car.

Consider, for instance, the case of a car which originally cost \$2,000 and which has been run three years. A very good return value on this car would be about \$900 and it would cost the buyer \$1,100 additional cash to obtain the new car. At less than one-fifth of this outlay the engine of his old car can be put in better condition than he will find to be the case in the new car.

What Makes an Engine Wear Out?

After an automobile has been run several seasons, the effects of wear on the engine commence to make themselves felt. In the case of motor trucks and tractors the wear generally becomes objectionable after running but one season. This is due to the heavy and continuous work these engines are called upon to perform.

The effect of wear is most noticeable in the following parts:

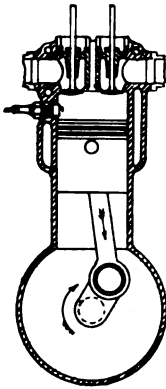
- Crankshaft bearings and pins
- Cylinders
- Pistons
- Piston pins
- Valves

The crankshaft is generally subject to two kinds of wear. Very often dirt or

grit gets into the oil in the crank case, or the oil level is allowed to become too low. Scored pins and bearings result.

The second kind of wear causes the pins and bearings to become out of round.

The illustration shows how this action takes place. The crankshaft and connecting rod are shown in the position which they occupy at the moment of ex-



plosion. At this instant an excessive downward pressure is brought to bear upon the upper part of the crank pin. Ultimately this will cause the crank pin to become somewhat flattened on top and allow play in the bearings. After a pin once becomes slightly flat on top, additional wear takes place quite rapidly due to the fact that a hammerblow takes place at each explosion. This of course is very detrimental to satisfactory engine operation.

The action described above also occurs in the case of the piston pin, the wear increasing rapidly after it has once started.

The cylinders wear on account of the friction and pressure of the piston rings. It is estimated that the bore of the cylinder will wear approximately .001" for every 1,500 to 2,000 miles. Furthermore, the cylinder does not wear uniformly and the hole becomes out of round; also there is much greater wear where the rings bear than where they do not.

The installation of new piston rings does not help this condition. It is impossible to make a ring fit a cylinder that is out of round or whose bore is not of uniform diameter.

In the case of the valves, more or less unequal wear takes place on the face and seat. In addition the heat of the explosion very often causes pitting. Under these conditions the valve becomes leaky.

Appreciable wear on the parts described above gives rise to many difficulties, among which are the following:

- Serious knocking
- Lack of original power
- Use of excessive amount of gas and oil
- Spark plugs foul
- Oil in crank case thinned with gasoline

How Can the Engine Be Renewed?

The answer to this question is by **REGRINDING**. By this means the crankshaft bearings and pins are made perfectly round, smooth, and straight. The same is true of the cylinder bore. New oversize piston pins are ground to fit oversize pistons, which are themselves ground to fit the cylinder bore.

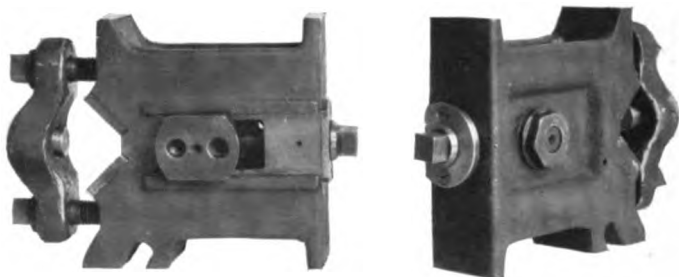
It is obvious that the old pistons, pins, and rings cannot be used, and it is therefore necessary to purchase new ones. There are many concerns who furnish oversize hardened pins, and there are many types of rings on the market that are finished to size. The question of the best way of buying pistons, however, requires some consideration.

The regrinding shop has the choice of buying the unfinished piston casting, semifinished oversize piston, or completely finished oversize piston. By far the larger number of regrinding shops purchase the semifinished oversize piston as this plan seems to be much more satisfactory than any other.

It does not seem economical for the



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End Blocks Furnished with the Machine for Grinding Crankshafts

necessary to put the gasoline engine in first-class condition. It will thus be seen that it constitutes what is essentially a grinding department for the small shop.

The following features adapt the machine for crankshaft work:

The large swing of 18" and center distance of 55"

Convenient, adjustable workholders
to take all sizes automobile crank-
shafts.

Large grinding wheels, 26" in diameter, to reach in when grinding long stroke motors

For pistons and small pieces the machine is provided with twelve work speeds, insuring proper action for even the smallest diameter work. An attachment is also provided for grinding all types of valves.

As shown in the illustration, the adjustable end blocks are arranged with hardened tool steel blocks which have been drilled with two 60° centers. This block is adjustable by means of an accurate micrometer screw and it can be clamped securely in any position. The crankshaft is clamped in a V-block in one end of the piece. It will be seen that this V-block clamping arrangement handles all sizes of crankshafts without the use of bushings.

The valve grinding attachment with which this machine is equipped is driven from the overhead drum by a round belt. It is adjustable and will grind valve faces of

any angle. It is also arranged to grind the centers of the machine which must be kept smooth and true in order to produce good work.

The Profits That Can Be Made

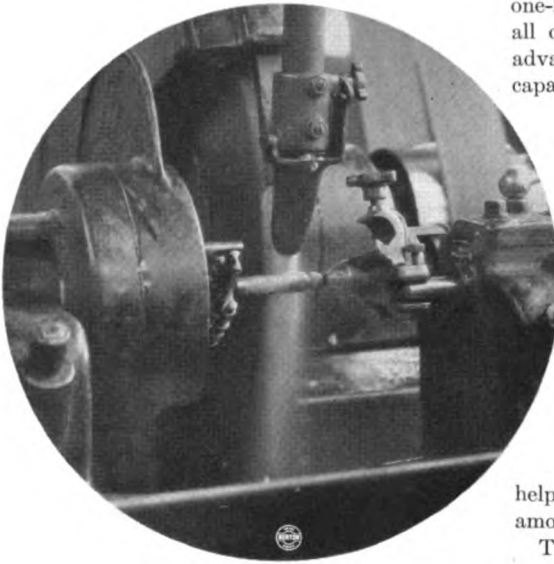
It is a somewhat remarkable fact that practically all the shops that have gone into this line of work are making money even during the present dull business conditions. In fact, we do not know of a single instance where ordinary business ability has been used, that good profits are not being made.

In order to see the amount of profit that could be earned, let us take the typical example of the **regrinding of a medium-priced four-cylinder engine including the regrinding of the crankshaft.**

Although labor costs differ somewhat in different parts of the country and the amount received for the work also differs somewhat, yet the margin between cost and selling price averages pretty much the same. Assuming the rather high cost figures of 80 cents per hour and 50% overhead, the profit to be expected in regrinding the crankshaft would be in the neighborhood of \$10. The average profit to be gained by regrinding the cylinder blocks, furnishing new piston pins and rings, would be in the neighborhood of \$10 to \$12.

It will therefore be seen that the total profit on the whole job would be from \$20





Grinding a Piston Pin to Fit the New Piston

industry, perseverance, progressiveness, and business ability, are required, but it is doubtful if there is a field existing today for the small shop where the possession of these elements will so quickly and apparently so surely bring such a substantial reward.

How To Get the Business

The regrounding business obtainable is apparently very large indeed. The proposition such a shop can offer its customer is of great value to him as it will save him anywhere from \$600 to \$1,000 or more; thousands of potential customers are right in the shop's immediate neighborhood; best of all, car owners have but recently begun to appreciate the advantages of regrounding. This is almost a virgin field and it looks as though it was destined to become one of the large and permanent industries of the country.

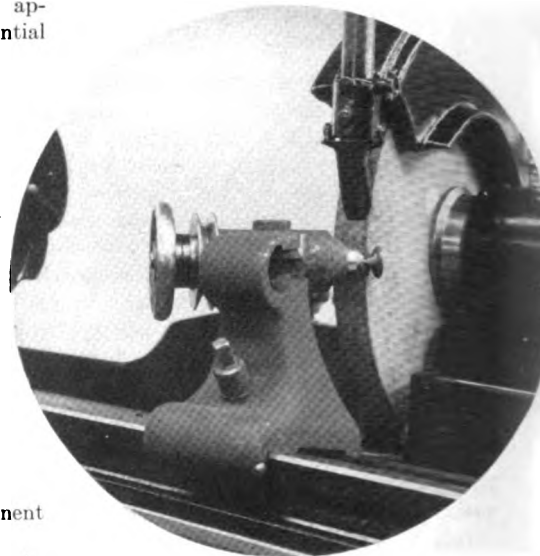
In 1919 there were registered throughout the country approximately seven and

one-half million motor cars. Practically all of these could be reground to great advantage in the next year or two. The capacity of all the shops doing regrounding work today could probably take care of but 7% to 8% of this total. It must also be remembered that each year over a million new cars are put into use.

There are several ways open to the regrinding shop for securing customers. One of the first steps should be the soliciting of garages. It will be found in most cases they will be glad to work with the regrinding shop as it is the practice to allow them a small commission. The activity of the garage man helps to popularize the idea of regrinding among his customers.

The car owner can be reached by personal interview, circular letter, advertising leaflets, or local newspaper advertising. One of the best advertisements the re-grinding shop has, however, is a satisfied customer.

The satisfaction of having an old engine



Regrinding Valve

[MAY-JUNE, 1921]



made better than new is so great that the customer will tell his friends about it. Many car owners will thus learn for the first time what regrounding is and what it will do for them. In this way the number of live prospects is constantly increasing. That conditions work out in this manner is proven by the fact that in communities having the greatest number of regrounding shops in proportion to the number of registered cars, the total amount of regrounding done is much greater than in similar communities having but few shops. In other words, a large proportion of the car owners have been educated to know about regrounding and thus a large total business is being done.

In conclusion we will say that all indications point to the fact that the regrounding business is peculiarly suitable for the small repair jobbing or welding shop, private individual, or garage. The future of the industry seems assured, and those who enter it now will establish themselves in what undoubtedly will be a permanent, growing, and profitable business.

We are convinced that it will be found that this represents by far the best opportunity that exists today, because so far as we know it possesses advantages applying to no other line of work. Some of these may be listed as follows:

- Large profits that can be made
- Small capital required
- Small amount of room necessary
- Great value of service rendered customer
- Ease of obtaining business
- Great number of potential customers nearby
- Permanency of business

The information contained in this article has been compiled from reliable sources and we believe the figures given are conservative.

There will probably be many questions that arise in the minds of those who contemplate entering this field and we believe that additional information may be helpful. Assistance of this kind will be gladly furnished.

No Abrasive Could Be Found in Ground Surface

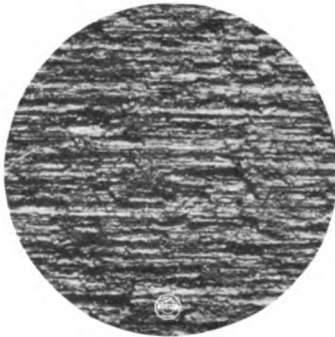
Many years ago when grinding was in its infancy and before it had reached the important place that it now holds in every plant where precision machines and tools are manufactured, occasionally someone not familiar with ground surfaces would come forth with the statement that ground work has particles of the abrasive from the grinding wheel imbedded in the finished surface. While this subject to those who have been in closer touch with modern grinding practice is considered "dark age stuff," we find that now and then somebody bobs up with the notion that abrasive grain is imbedded in ground surfaces.

Only recently samples were submitted to the Norton Company's Research Laboratories with the request for a

thorough test and report as to whether or not any abrasive can be found on the surface of ground cylinders. The Laboratory report follows:

"The first examination of the sample submitted was made using the highest magnification possible with a binocular microscope. This examination did not show the presence of any vitreous grain imbedded in the metal. Frequently small pits were found but these contained no abrasive and are undoubtedly small blow holes in the metal.

"One-half of the sample was then dissolved in a 1 to 1 hot hydrochloric plus 5% sulphuric acid mixture. It was then filtered and washed with hot dilute hydrochloric acid until the filtrate came colorless, after which the residue was



Magnified Surface of a Reamed Cylinder

dried and examined microscopically for the presence of silicon carbide. No trace of this product could be found.

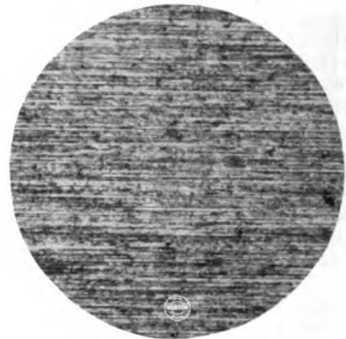
"The other half of the sample was polished on a small felt wheel coated with crocus in order to remove the finer scratches. The surface was then examined in reflected light with a metallographic microscope. No particles resembling abrasive were found. A portion of this polished surface was then etched with a 5% nitrate acid solution and again examined. Nothing was found which would indicate abrasive particles.

"We are therefore led to the conclusion that at least as far as the sample submitted

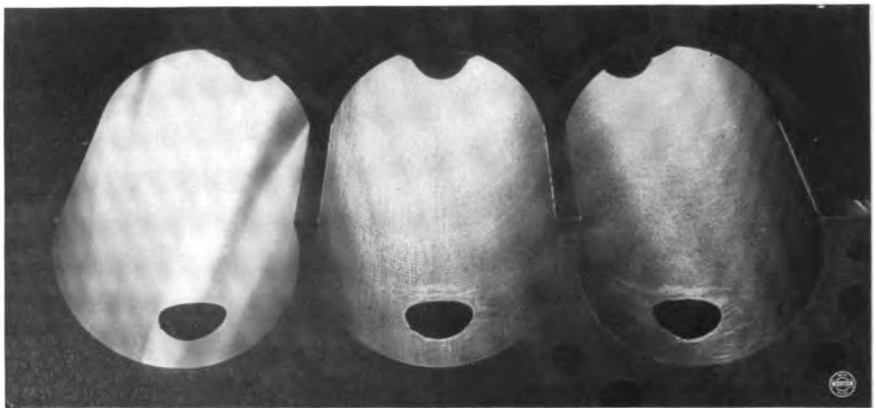
is concerned there was no abrasive imbedded in the surface of the metal."

As a matter of interest we are showing here photomicrographs of the surfaces of two different cylinders in the same cylinder head of a certain motor. One shows the surface magnified of the original reamed cylinder and the other a ground cylinder. Pictures were made through a microscope, magnification 12 diameters.

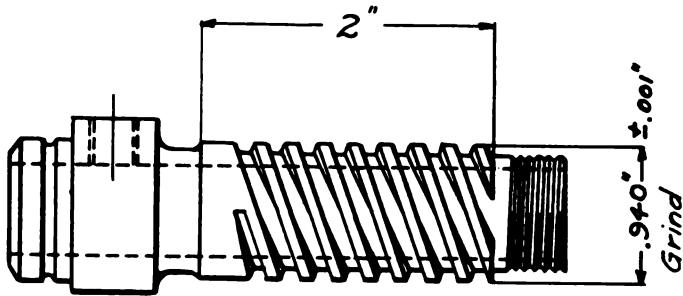
The other illustration is an actual photograph of the walls of three cylinders. The cylinder on the right is a reamed cylinder just as it comes from the factory new. The cylinder in the middle was partly ground, plainly showing where the grinding wheel hit the high spots. On the left is a finished ground cylinder.



Magnified Surface of a Ground Cylinder



Photograph of Cylinder Head Showing a Ground Cylinder (left), a Partly Ground Cylinder (center), and a Reamed Cylinder (right)



An Extraordinary Example of Rapid Production When All Conditions Are Ideal

Screw shaft for Eclipse-Bendix starting drive showing surface ground. Material, case hardened steel; limits, $\pm .001''$; stock removed, .012'' approx.; machine, Norton 6 x 32; wheel, Alundum 50 M; speed of wheel, 6,000 s. p. m.; speed of work, 265 r. p. m.; production, 2,100 pieces in ten hours.

The above is an unusually good record for production. It was done by one operator, without assistance, in the plant of the Eclipse Machine Co., Elmira Heights, N. Y.

The work is placed on a taper mandrel and given a blow on one end of the man-

drel to secure it and is taken off the mandrel by hitting the mandrel on the opposite end. Two mandrels are used and a block of hard wood 6'' x 6'' x 3' is placed on end near the operator's right hand to facilitate the work. The operator loads his work while the machine is grinding, four traverses only being made using the automatic feed, reducing the work to size in three traverses, the last or fourth traverse giving the work a good commercial finish. There is a table each side of the operator; the one on the right has a pan of work on it ready to grind and the one on the left holds the finished product.

Dresser Used on Blanchard Machines

Blanchard Vertical Surface Grinders are equipped with a special dresser shown here. The device provides a quick, safe way of dressing or sharpening the wheel. It consists of a vertical bronze shaft, carried in a substantial bearing attached to wheel head, having at its lower end an arm holding a group of toothed steel cutters, and at its upper end a handle for swinging the cutters across the wheel face. Micrometer adjustment for height is provided by a hand nut just below the operating handle. With work held on the standard 26-inch chuck and not projecting, the dresser can be operated without interrupting the grinding. In the case of larger work, or oversize chuck of faceplate, the chuck must be moved out a few inches to allow room for dresser to operate. The dresser can be attached to any Blanchard No. 16 Grinding Machine.



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GRITS and GRINDS

JULY-AUGUST, 1921

Factors affecting
**GRINDING
WHEEL
SELECTION**



Grits and Grinds

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Factors Affecting Grinding Wheel Selection

By W. T. MONTAGUE

The selection of a grinding wheel for a given piece of work is not a guess—neither is it calculable by mathematics. In other words, grinding is still largely an art, although recently much progress has been made in uncovering and understanding certain scientific principles which apparently underlie correct grinding practice as we know it to-day.

Grinding plays such an important part in our modern manufacturing processes, whether crude or refined, that an understanding of the factors involved in selecting a grinding wheel for a certain job is extremely helpful to the shop superintendent, methods engineer, foreman, or workman. The purpose of this article is to show just what factors have to be considered and the relative importance of each.

One well-informed writer on grinding states that three general factors govern grinding wheel selection—

1. Characteristics of the grinding wheel as determined by its manufacture
2. Nature of the material to be ground
3. Factors having to do with methods and conditions

This is very well put, but perhaps the further subdivision of these factors will help some to a more complete understanding of the subject.

Given Conditions

1. Material to be ground
2. Amount of material to be removed and finish desired
3. Arc of contact
4. Type of grinding machine

Influential Variable Factors

1. Wheel speed
2. Work speed (or pressure if off-hand grinding)
3. Condition of machine
4. Skill of the workman

The characteristics of a grinding wheel are completely described by listing the abrasive of which it is composed, its grit, grade, and the process used in its manufacture (vitrified, silicate, elastic, or rubber). The four "given conditions" listed above determine approximately the abrasive, grit, grade, and process that a wheel should have; but to come closer to the mark, we must immediately temper our judgment or alter our decisions by considering the effect of the four variable factors shown. An attempt will be made to show this in the following paragraphs.

Given Conditions

1. Material to be Ground

The physical properties of a material to be ground largely govern the selection of the type of abrasive to be used. For instance, experience has taught us that the physical property, tensile strength, is almost always the factor that determines whether crystalline aluminum oxide or silicon carbide abrasives should be chosen. For materials of high tensile strength, beginning with the hardest and toughest of alloy steels down to and including the tougher grades of bronze, crystalline aluminum oxide wheels should be used. These are the grinding wheels branded by Norton Company as Alundum.

Different degrees of hardness, toughness, and ductility in metals are now successfully handled with Alundum abrasives of different tempers, designated as regular, # 38 and # 66, these abrasives being designed by electro-chemists to have certain specific physical properties to meet the conditions imposed by these metals, but space does not permit a discussion of their qualities here.

Materials of low tensile strength, such as soft brasses and bronzes, cast and chilled iron, aluminum, copper, and marble, are more efficiently ground with

silicon carbide wheels (as Norton Company's Crystolon Brand).

2. Amount of Material to be Removed

The amount of material to be removed by the grinding wheel and the finish desired are factors that should not be overlooked. They influence the selection of the grit size to be employed because, where comparatively large amounts of material have to be removed by grinding, the coarser grain combinations should be employed to facilitate the rapid removal of stock. This applies particularly to offhand grinding operations like snagging castings, where finish is no consideration, but rapid cutting qualities are essential.

Finish is dependent to a considerable extent on grit size used, except on machine grinding operations where proper truing and dressing facilities afford a means of obtaining fine finish without the sacrifice of production usually accompanying the use of fine grit wheels.

3. Arc of Contact

By "arc of contact" is meant the length of the arc (measured along the periphery of a straight or disc shape grinding wheel) that is in contact with the work being ground. This is sometimes confused with width of contact which has practically no effect on cutting action, provided pressure per unit area remains constant and there is sufficient power in the drive. In the case of cup or cylinder wheels where the grinding is done on the rim, the important factor is the "area of contact."

"Arc of contact" or "area of contact" has a very important bearing on the grade (degree of hardness) of the grinding wheel, in all classes of grinding, whether precision or offhand.

The sharper the contact, the harder the wheel should be and vice versa. This may be illustrated by considering the grinding of hardened steel balls where practically "point contact" exists, and as a result grade Z or the hardest possible grade of wheel should be used. The opposite extreme is surface grinding with a cup or cylinder wheel, where the "area of contact" may be several square inches. Here the very softest grades have to be employed to grind satisfactorily—i. e., grades G, H, and I (Norton scale of hardness).

4. Type of Grinding Machine

In the majority of cases when a grinding wheel has to be selected for a given job, the grinding machine is already available and hence this becomes an important factor in grinding wheel selection.

The type or design of the machine is responsible for certain conditions that have to be carefully considered and only long experience in selecting wheels for various makes and types enables one to take these factors into account properly. This statement may be clarified by saying that heavy, rigidly constructed machines take softer wheels than lighter, more flexible types; that some machines set up greater vibrations than others, thus calling for finer and harder wheels; that the combination of speeds and feeds on some precision machines makes the use of different kinds of wheels necessary; that plane surface grinding machines making use of the rim of a cup or cylinder wheel require much softer wheels than plane surface machines using the periphery of a straight or disc wheel.

Influential Variable Factors

1. Wheel Speed

The speed at which a grinding wheel revolves is important because too slow a speed means wastage of abrasive without getting much useful work in return whereas an excessive speed usually retards cutting and if carried too far might become dangerous. As a general proposition it is better to operate a grinding wheel at somewhere near the speed recommended by the maker, as he has found by years of experience that certain speeds work better than others. For instance, for surfacing a piece of steel he would probably recommend in the neighborhood of 4,000 s. f. p. m. whereas for cutting off the same material (with an elastic or rubber bonded wheel) he would probably suggest 8,000 or 9,000 s. f. p. m.

The grits and grades usually recommended for certain grinding operations are based on the assumption that approximately the recommended speeds will be employed. If for some reason they cannot be, then the grade at least must be changed to suit this condition.

2. Work Speed

In machine grinding, speed of work exerts a very pronounced effect on the grinding wheel and hence has to be allowed for in grinding wheel selection. In general fast work speed, whether the operation be cylindrical, surface, or internal grinding, tends to wear the wheel out faster than slower work speed. This is not necessarily a drawback to good grinding practice but it must be understood to be properly controlled.

In general, the longer the arc of contact in precision grinding operations, the faster

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2. Selection of the Grit

Influential Factors:

- | | |
|--|--|
| A. Amount of material to be removed..... | { Use coarse wheels for fast removal of stock |
| B. Finish desired..... | { Use fine grain for fine finish, except in machine grinding operations |
| C. Physical properties of material to be ground..... | { Use coarse grain for ductile materials and finer grain for hard, dense, or brittle materials |

3. Selection of the Grade (Degree of Hardness)

Influential Factors:

- | | |
|--|---|
| A. Physical properties of the material to be ground... | { Use hard wheels on soft materials and vice versa |
| B. Arc of contact..... | { The shorter the contact, the harder the wheel should be |
| C. Wheel speed..... | { The higher the wheel speed, the softer the grade and vice versa |
| D. Work speed..... | { The higher the work speed, the harder the grade should be and vice versa |
| E. Condition of Grinding Machine..... | { Machines in poor condition require harder wheels than machines in good condition
Bearings must be kept adjusted
Foundation must be solid
Machine must be of rigid construction |
| F. Skill of operator..... | { Skillful operator can use softer wheels than unskilled man—softer wheels mean more economical production
Piece-work grinding usually calls for harder wheels than day work |



4. Selection of the Process

Influential Factors:

	Wheels subjected to bending strains should be made by elastic or rubber process
A. Dimensions of wheel.....	Extremely thin abrasive saws must be made by the elastic or rubber process
	Wheels over 36" diameter are usually made by the silicate process
B. Rate of cutting.....	Use vitrified wheels for most rapid cutting
	Use elastic wheels for highest finish, where rapid production is not a factor
C. Finish desired.....	Use silicate wheels to replace sandstones on cutlery, etc.

Table of Grinding Wheel Recommendations

Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Agate			
Off-hand roughing	Crys. Vit.	80 K	80-K to 120-I
Off-hand finishing	Crys. Vit.	F J	F-J
Aluminum			
Cylindrical	Crys. Vit.	40 J	30-K to 40-J
	Alun. Elas.		6630-3 to 6636-2
	Alun. Vit.		6624C-M to 6624C-K
Surface (Cups & Cyls.)	Alun. Vit.	3824 I	3820-J to 3824-H
	Crys. Vit.		16-I
	Crys. Vit.	24 J	24-J
Internal Snagging	Alun. Elas.	6636 5	6630-6 to 6646-4
	Crys. Elas.		30-6 to 46-4
	Crys. Vit.		24-R to 36-O
Armatures (Laminations)			
Cylindrical	Alun. Vit.	6636 I	6630-J to 6636-I
Axes (Soft Steel)			
Siding	Alun. Vit.	6636 R	6630-R to 6636-Q
Edging	Alun. Vit.	6630 S	6624-U to 6630-S
Axles (Auto)			
Cylindrical	Alun. Vit.	6646 L	6646-L to 6646-K
Balls (Soft)			
1st Roughing	Alun. Vit.	36 Z	36-Z to 60-W
2nd Roughing	Alun. Vit.	120 Z	90-Z to 120-Z
Balls (Hard or Soft—Small)			
1st Finishing	Alun. Vit.	180 Z	180-Z
Balls (Hard or Soft—Large)			
1st Finishing	Alun. Vit.	80 Z	80-Z
Balls (Small—Hard)			
Final Finishing	Alun. Vit.	XF Z	XF-Z
Ball Races (Soft Steel)			
Rough Surfacing (Cups & Cyls.)	Alun. Sil.	3820 J	3816-J to 3824-H
Ball Races (Hardened Steel)			
Finish Surfacing (Cups & Cyls.)	Alun. Sil.	3830 G	3824-H to 3836-G
Cylindrical	Alun. Vit.	6646 K	6636-L to 6650-K
Rough Grooving (Inner Race)	Alun. Vit.	6646 L	6636-M to 6646-K
	Alun. Vit.		3836-M to 3846-K
Finish Grooving (Inner Race)	Alun. Vit.	6670 K	6650-N to 6670-K
	Alun. Vit.		3850-N to 3870-K
	Alun. Elas.		6660-3 to 6660-2½
Rough Grooving (Outer Race)	Alun. Vit.	6646 K	6636-L to 6646-J
	Alun. Vit.		3836-L to 3846-J



Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Finish Grooving (Outer Race)	Alun. Elas.	6680	4
	Alun. Vit.		6680-4 to 66100-2½
	Alun. Vit.		6660-L to 6680-K
Internal	Alun. Vit.	6660	K
	Alun. Vit.		3860-L to 3880-K
	Alun. Vit.		6646-M to 6660-K
	Alun. Vit.		3846-M to 3860-K
Bath Tube			
Snagging	Crys. Vit.	24	S
20-U to 30-S			
Billets (High Carbon Steel)			
Cleaning	Alun. Vit.	14	R
12-S to 16-Q			
Billets (Alloy Steel)			
Cleaning	Alun. Vit.	20	R
12-R to 20-P			
Bits (Auger)			
Roughing End	Alun. Rub.	36	
30 to 36			
Fluting	Alun. Rub.	70	
70			
Bolts (Case-hardened Steel)			
Cylindrical	Alun. Vit.	6636C	L
6636C-N to 6636C-L			
Brake Shoes (Chilled Iron)			
Snagging	Crys. Vit.	24	S
16-U to 24-S			
Brass			
Cylindrical	Crys. Vit.	36	J
36-K to 36-J			
Internal	Crys. Vit.	36	J
36-K to 46-I			
Surfacing (Cups and Cyls.)	Crys. Vit.	24	H
24-J to 30-H			
Snagging	Crys. Vit.	24	Q
24-Q to 30-P			
Cutting-off	Crys. Vit.	36	V6
36-V7 to 50-V6			
Broaches			
Sharpening	Alun. Vit.	6646	K
6646-K to 6650-K			
	Alun. Vit.		3836-L to 3850-K
	Alun. Elas.		6636-2½
Bronze (Soft)	<i>Use same wheels as for Brass</i>		
Bronze (Hard)	<i>Use same wheels as for Soft Steel</i>		
Buhr Stones			
Grooving (Narrow)	Crys. Elas.	36	V7
36-V7			
Grooving (Wide)	Crys. Vit.	24	M
24-M			
Bushings (Hardened Steel)			
Cylindrical	Alun. Vit.	6646	K
6630-L to 6646-J			
Internal	Alun. Vit.	3846	K
3846-M to 3880-J			
Bushings (Cast Iron)			
Cylindrical	Crys. Vit.	36	J
30-L to 36-J			
Internal	Crys. Vit.	36	J
36-K to 46-I			
Cams (Rough Forging)			
Roughing	Alun. Vit.	30	P
24-R to 36-P			
Cams (Hardened Steel)			
Finishing	Alun. Vit.	6624C	J
6624C-K to 6624C-J			
	Alun. Vit.		6646-K to 6646-J
	Alun. Vit.		3824C-K to 3824C-J
	Alun. Vit.		3846-K to 3846-J
Cam Rollers (Hardened Steel)			
Internal	Alun. Vit.	3860	L
3850-M to 3860-K			
Car Wheels (Chilled Iron)			
Cylindrical	Crys. Vit.	16	Q
16-R to 24-P			
Car Wheels (Steel)			
Cylindrical	Alun. Vit.	20	P
16-Q to 24-N			
Car Wheels (Manganese Steel)			
Cylindrical	Alun. Vit.	16	Q
14-R to 16-Q			
Carbon (Soft)			
Cutting-off	Crys. Rub.	16	
16 to 30			
Carbon (Hard-Thin)			
Cutting-off	Crys. Rub.	60	
46 to 60			
Carbon (Hard-Thick)			
Cutting-off	Crys. Rub.	24	
20 to 30			
Carbon (Metallic)			
Cutting-off	Crys. Spec.		
	Elastic	30	6
30-6 to 30-5			
Radius Grinding	Crys. Elas.	36	4
36-4 to 60-3			
Carbon (Hard or Soft)			
Surfacing	Crys. Vit.	30	J
30-J to 46-I			
Radius Grinding	Crys. Vit.	36	J
36-K to 60-J			
Cast Iron			
Cylindrical	Crys. Vit.	36	J
30-L to 36-J			
Internal	Crys. Vit.	36	J
36-K to 46-I			
Surfacing (Cups & Cyls.)	Crys. Vit.	24	H
20-J to 24-H			
Surfacing (Straight Wheels)	Crys. Vit.	30	J
30-K to 46-I			
Snagging	Crys. Vit.	20	S
16-U to 24-R			
Chain Links (Malleable Iron and Steel)			
Snagging	Alun. Vit.	24	R
24-R to 24-Q			

Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Chain Links (Unannealed Malleable Iron)			
Snagging	Crys. Vit.	24 S	16-T to 24-R
Chasers (Thread)			
Surfacing	Alun. Vit.	3846 J	3846-K to 3846-J
Grinding Throats	Alun. Elas.	6660 3	6660-3
Chilled Iron			
Snagging	Crys. Vit.	24 S	16-U to 24-S
Chisels			
Surfacing (Cups and Cyls.)	Alun. Elas.	6646 5	6640-V6 to 6650-5
Sharpening	Alun. Vit.	46 M	46-N to 50-M
Commutators			
Roughing (Wheels)	Crys. Elas.	46 2½	46-2½
Finishing (Wheels)	Alun. Elas.	6646-2	6646-2
	Crys. Elas.	80 2	80-2
	Alun. Elas.	6680-2½	6680-2½
Both Operations (Wheels)	Crys. Elas.	60 3	60-3
Roughing (Bricks)	Alun. Elas.	6680 2½	6680-2½
Finishing (Bricks)	Alun. Elas.	66120 1½	66120-1½
Connecting Rods			
Internal	Alun. Vit.	3860 K	3860-L to 3860-K
Copper			
Cylindrical	Crys. Elas.	70 1½	60-2½ to 80-1½
Couplers and Draw Bars			
Snagging	Alun. Vit.	10 U	10-W to 12-U
Crankshafts (Pins and Bearings)			
Roughing	Alun. Vit.	36 O	36-Q to 36-O
Finishing	Alun. Vit.	24C M	24C-N to 24C-L
	Alun. Vit.		46-N to 46-L
Cutlery (See Knives)			
Cutters (Formed)			
(Gear)			
(Hob)			
(Inserted Tooth)			
(Milling)			
Sharpening	Alun. Vit.	6646 J	6636-K to 6660-J
	Alun. Vit.		3836-K to 3860-J
Cutters (Molding)			
Off-hand Sharpening	Alun. Vit.	46 M	46-P to 60-M
Cylinders			
Internal	Crys. Vit.	36 H	30C-J to 40-H
Regrinding	Crys. Vit.	36 H	30C-J to 40-H
Dies (Forging)			
Cleaning	Alun. Vit.	60 P	46-Q to 60-O
Dies (Threading)			
Chamfering (Cone Wheel)	Alun. Vit.	80 P	80-Q to 80-P
Dies (Drawing)			
Cleaning	Alun. Vit.	60 L	46-M to 60-K
Surfacing (Cups and Cyls.)	Alun. Sil.	3824 I	3824-J to 3830-H
Surfacing (Straight Wheels)	Alun. Vit.	3846 I	3836-K to 3846-I
Draw Bars and Couplers			
Snagging	Alun. Vit.	10 U	10-W to 12-U
Drills			
Cylindrical	Alun. Vit.	50 N	46-N to 60-M
Precision Sharpening	Alun. Vit.	46 L	36-L to 46-K
Point Thinning	Alun. Elas.	6650 2	6646-3 to 6650-2
Drills (Small)			
Fluting	Alun. Rub.	46	46 to 60
Off-hand Sharpening	Alun. Vit.	60 N	50-O to 80-M
Drills (Large)			
Fluting	Alun. Vit.	46 P	46-R to 60-P
Off-hand Sharpening	Alun. Vit.	24 P	24-P to 46-O
Files			
Surfacing	Alun. Sil.	6636 N	6630-O to 6636-M
Forgings			
Snagging	Alun. Vit.	20 R	16-R to 24-P
Fork Tines			
Off-hand	Alun. Vit.	36 R	36-S to 36-R
Frogs and Switches (Manganese Steel)			
Off-hand Grooving	Alun. Vit.	20 P	16-Q to 24-O
	Alun. Vit.		6616-Q to 6624-O
Semi-Precision Grooving	Alun. Vit.	16 Q	14-S to 16-Q
	Alun. Vit.		6614-S to 6616-Q

Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Snagging	Alun. Vit.	14 R	12-S to 16-Q
Surfacing	Alun. Vit.	14 R	6612-S to 6616-Q
Gages (Plug)			
Cylindrical	Alun. Vit.	6680 K	6660-K to 66100-J
Gages (U. S. Thread, Coarse Pitch)			
Grinding Threads	Alun. Vit.	38120 K	38120-L to 38120-K
Gages (U. S. Thread, Medium Pitch)			
Grinding Threads	Alun. Vit.	38200 K	38200-L to 38200-K
Gages (U.S. Thread, Fine Pitch)			
Grinding Threads	Alun. Vit.	38200 M	38200-O to 38200-M
Gears			
Cleaning between teeth	Crys. Rub.	46	36 to 60
Glass			
Deep Mitre Work	Norton Deep Mitre Stone		
Medium Mitre Work	Norton Medium Mitre Stone		
Fine Mitre Work	Norton Fine Mitre Stone		
Light Ware	Norton Light Ware Stone		
Glass Lenses			
Hand Edging	Alun. Vit.	120 M	120-M
Machine Edging	Alun. Vit.	200 M	200-N to 200-M
Glass (Plate)			
Rough Beveling	Crys. Vit.	100 I	90-I to 100-H
Glass (Tumblers)			
Edging	Alun. Vit.	150 M	120-O to 180-M
Granite			
Coping	Crys. Elas.	14 V7	14-V7 to 16-V7
Guide Bars			
Face Grinding	Alun. Sil.	6616 M	6616-M to 6620-K
Hammers (Claw)			
Grinding between claws	Alun. Rub.	46	46 to 60
All other Operations	Alun. Vit.	6630 P	24-P to 36-O
Knives (Butcher)			
Surfacing	Alun. Elas.	6650 4	6646-5 to 6660-4
Knives (Chipper and Barker)			
Sharpening	Alun. Sil.	6636 J	6630-K to 6646-I
Knives (Hog)			
Sharpening	Alun. Sil.	6636 J	6630-K to 6646-I
Knives (Leather Fleshing)			
Sharpening (Bricks)	Alun. Vit.	24 R	24-R to 46-O
Knives (Leather Shaving)			
Sharpening	Alun. Vit.	6650 O	6650-P to 6650-O
Knives (Leather Splitting)			
Sharpening	Alun. Elas.	6630 1½	6630-1½ to 6636-1½
Knives (Moulding)			
Off-hand Sharpening	Alun. Vit.	36 M	36-N to 46-L
Knives (Machine)			
Sharpening	Alun. Sil.	6636 J	6630-K to 6646-I
Knives (Paper)			
Sharpening	Alun. Sil.	6636 J	6630-K to 6646-I
Knives (Pocket)			
Machine Surfacing	Alun. Elas.	6660 V6	6646-V6 to 6660-4
Off-hand Surfacing	Alun. Sil.	66120 O	6690-P to 66120-N
Knives (Section)			
Beveling	Alun. Sil.	6636 M	6636-M to 6636-L
Surfacing Backs	Alun. Sil.	6636 I	6636-I
Knives (Sugar Beet)			
Rooting	Alun. Elas.	6646 5	6646-5
Knives (Table)			
Surfacing Blades	Alun. Elas.	6646 4	6646-V6 to 6660-3
Knives (Veneer)			
Sharpening	Alun. Sil.	6636 J	6630-K to 6646-I
Links (Locomotive)			
Machine Grinding	Alun. Vit.	46 P	36-P to 60-M
Links (Chain Malleable Iron and Steel)			
Snagging	Alun. Vit.	24 R	24-R to 24-Q

Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Links (Chain Unannealed Malleable Iron)			
Snagging	Crys. Vit.	24 S	16-T to 24-R
Machine Shop Grinding			
General Off-hand	Alun. Vit.	24 Q	24-Q to 30-O
Malleable Iron Annealed			
Snagging	Alun. Vit. Alun. Rub.	20 R	20-S to 24-Q 12 to 16
Malleable Iron Unannealed			
Snagging	Crys. Vit.	20 S	16-S to 20-R
Marble			
Coping	Crys. Elas.	14 V6	14-V7 to 20-V6
Surfacing (Segments)			
1st Gritting	Crys. Vit.	120 K	120-K
2nd Gritting	Alun. Vit.	180 I	180-J to 200-I
Honing	Alun. Elas. Alun. Vit.	XF 5	XF-5 to XF-4 2F-J
Surfacing (Wheel)			
Roughing	Crys. Vit.	8 K	8-L to 8-K
Finishing	Crys. Vit.	36 J	24-L to 46-J
Moulding			
Roughing	Crys. Vit.	8 K	8-L to 8-K
Finishing	Crys. Vit.	36 J	24-L to 46-J
Metallographic Specimens			
Roughing	Alun. Vit.	80 P	80-P
Finishing	Alun. Vit.	200 M	200-M
Monel Metal			
Cutting-off	Alun. Rub.	6616	6616
Needles			
Pointing	Alun. Vit.	6670 P	6650-Q to 6670-P
Pins			
Pointing	Alun. Vit.	120 R	90-Z to 200-R
Pipe (Soft Steel)			
Cutting-off	Alun. Elas.	6646 5	6646-V6 to 6650-4
Pipe Balls (Manganese Steel)			
Cylindrical	Alun. Vit.	36 N	24-Q to 36-N
Regrinding	Alun. Vit.	46 M	46-N to 46-M
Pistons (Aluminum)			
Cylindrical	Crys. Vit. Alun. Elas. Alun. Vit.	40 J	36-K to 40-J 6636-2 6624C-M to 6624C-K
Pistons (Cast Iron)			
Cylindrical	Crys. Vit.	36 K	36-L to 46-J
Piston Pins			
Cylindrical	Alun. Vit.	6636C L	6636C-M to 6636C-K 3836C-M to 3836C-K
Piston Rings (Cast Iron or Semi-Steel)			
Cylindrical	Crys. Vit.	36 K	30-M to 36-K
Surfacing Roughing (Cylinder)	Crys. Vit.	20 J	16-M to 24-J
Surfacing (Straight Wheels)	Alun. Vit.	6650 N	6636-N to 6650-L
Internal (Off-hand)	Crys. Vit.	20 Q	16-R to 20-Q
Plows (Steel)			
Surfacing	Alun. Vit.	16 R	16-R to 20-Q
Fitting	Alun. Vit.	20 R	20-S to 24-Q
Edging and Jointing	Alun. Vit.	16 R	16-S to 16-Q
Plows (Chilled Iron)			
Surfacing	Crys. Vit.	16 T	16-T to 24-R
Edging and Jointing	Crys. Vit.	16 Q	16-Q
Fitting	Crys. Vit.	20 S	20-U to 20-S
Pulleys (Cast Iron)			
Cylindrical	Crys. Vit.	30 J	24-L to 30-J
Rails (Welds)			
Surfacing	Alun. Vit.	20 O	16-Q to 24-O
Razors			
Concaving	Alun. Vit.	70 N	70-O to 80-L
Honing	Alun. Elas.	66200 1½	66200-2 to 66F-1½
Razors (Safety)			
Sharpening	Alun. Vit.	L897 J	L897-K to L897-J
Reamers			
Backing-off	Alun. Vit.	6646 K	6646-L to 6650-J 3846-L to 3850-J
Cylindrical	Alun. Vit.	6646 K	6646-L to 6660-J 3846-L to 3860-J

Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Fluting	Alun. Rub.	80	60 to 80
Rifle Barrels			
Cylindrical	Alun. Vit.	6624C	L 6624C-M to 6624C-K 6646-M to 6646-K
Rims (Automobile)			
Removing Welds	Alun. Vit.	24	20-S to 24-Q
Grooving	Alun. Rub.	30	24 to 30
Roller Bearing Cups			
Cylindrical	Alun. Vit.	6660	J 6650-K to 6660-J
Internal	Alun. Vit.	3860	J 3846-L to 3880-J
Rollers for Bearings			
Cylindrical	Alun. Vit.	66100	O 6690-O to 66100-N
Rolls (Hardened Steel)			
<i>Farrell Type Machine</i>			
Roughing	Alun. Vit.	6646	L 6646-L
Finishing	Alun. Elas.	6670	1½ 6670-1½
<i>Norton Type Machine</i>			
Cylindrical	Alun. Vit.	3846	J 3846-K to 3846-J
Cylindrical (High Finish)	Crys. Elas.	XF	I XF-I
Rolls (Chilled Iron)			
<i>Farrell Type Machine</i>			
Roughing	Crys. Vit.	36	K 24-L to 36-K
Finishing	Alun. Elas.	6670	1½ 6660-2 to 6680-1½
<i>Norton Type Machine</i>			
Cylindrical (Hot Plate Rolls)	Crys. Vit.	24	K 24-L to 30-K
Cylindrical (Dryer Rolls)	Crys. Vit.	46	J 46-J
Cylindrical (Rolls for Cold Rolling Steel)	Crys. Vit.	80	J 60-K to 80-J
Rolls (Cast Iron)			
Cylindrical (Roughing)	Crys. Vit.	30	K 30-L to 36-K
Cylindrical (Finishing)	Crys. Vit.	80	J 60-K to 80-J
Rolls (Brass)			
Cylindrical (Roughing & Finishing)	Crys. Elas.	46	2 36-3 to 46-2
Rolls (Soft Rubber)			
Cylindrical (Roughing & Finishing)	Crys. Vit.	36	K 36-K
Rolls (Hard Rubber)			
Cylindrical (Roughing & Finishing)	Crys. Vit.	36	K 36-K to 46-J
Rubber (Soft)			
Cylindrical	Crys. Vit.	36	K 36-K
Rubber (Hard)			
Cylindrical	Crys. Vit.	36	K 36-K to 46-J
Sad Irons			
Surfacing (Cups and Cyls.)	Crys. Vit.	20	H 14-J to 20-H
	Alun. Sil.		3814-I
Surfacing (Off-hand)	Crys. Vit.	16	N 16-N to 20-L
Snagging	Crys. Vit.	16	Q 16-Q to 24-P
Safes (Manganese Steel)			
Snagging	Alun. Vit.	16	Q 14-Q to 16-O
	Alun. Vit.		6614-Q to 6616-O
Surfacing	Alun. Vit.	20	O 20-P to 24-N
	Alun. Vit.		6620-P to 6624-N
Saws (Band)			
Gumming	Alun. Vit.	6646	M 6636-M to 6650-L
	Alun. Elas.		6630C-5 to 6630C-4
Saws (Circular)			
Gumming	Alun. Vit.	6646	M 6636-N to 6646-N
Saws (Metal Cutting)			
Gumming	Alun. Vit.	6660	P 6650-Q to 6680-P
Saws (Metal Slitting)			
Gumming	Alun. Elas.	6680	V6 6660-V7 to 6680-V6
Backing-off	Alun. Vit.	6646	I 6646-J to 6660-I
	Alun. Vit.		3846-I to 3860-I
Slate			
Coping	Crys. Elas.	16	V6 16-V6 to 20-5
Spline Shafts			
Cylindrical	Alun. Vit.	6646	K 6646-N to 6650-K
Grinding Splines	Alun. Vit.	6646	K 6636-L to 6650-J
	Alun. Vit.		3836-L to 3850-J
Springs (Leaf)			
Grinding Eyes	Alun. Vit.	24	Q 16-R to 24-O
Chamfering	Alun. Vit.	24	Q 24-R to 30-Q
Springs (Coil)			
Squaring Ends	Alun. Vit.	24	Q 16-R to 24-P



Work and Operation	Abrasive Process	1st Selection Grain-Grade	Usual Range of Grain and Grade
Shovels			
Off-hand	Alun. Vit.	24 R	16-S to 24-Q
Steel Castings (Low Carbon)			
Snagging (Swing Frame)	Alun. Vit.	12 S	10-W to 16-R
Snagging (Floor Stand)	Alun. Vit.	14 R	12-S to 16-Q
Snagging (Small Bench Stand)	Alun. Vit.	24 Q	24-Q to 36-O
Snagging (Portable Machine)	Alun. Vit.	24 R	16-S to 24-Q
Steel Castings (Manganese)			
Snagging (Swing Frame)	Alun. Vit.	16 R	14-U to 16-Q
Snagging (Floor Stand)	Alun. Vit.	16 Q	6614-U to 6616-Q
			14-T to 20-P
			6614-T to 6620-P
Steel (Soft)			
Cylindrical	Alun. Vit.	6624C	M 6624C-N to 6624C-L
	Alun. Vit.		6636C-N to 6636C-L
	Alun. Vit.		6646-N to 6646-L
Surfacing (Cups and Cyls.)	Alun. Vit.	3816 J	3816-K to 3824-I
Surfacing (Straight Wheels)	Alun. Vit.	3836 K	3824-L to 3836-J
Cutting-off	Alun. Rub.	36	30-36
Internal Grinding	Alun. Vit.	3846 L	3836-N to 3846-K
Steel (Hardened)			
Cylindrical	Alun. Vit.	6624C	K 6624C-K to 6624C-J
	Alun. Vit.		6636C-K to 6636C-J
	Alun. Vit.		6646-K to 6646-J
Surfacing (Cups and Cyls.)	Alun. Sil.	3830 G	3824-I to 3846-G
Surfacing (Straight Wheels)	Alun. Vit.	3836 H	3830-J to 3846-H
Cutting-off	Alun. Elas.	6646 5	6646-5 to 6646-4
Internal	Alun. Vit.	3860 J	3846-K to 3860-H
Steel (High Speed)			
Surfacing (Cups and Cyls.)	Alun. Sil.	3830 G	3816-I to 3836-G
Surfacing (Straight Wheels)	Alun. Vit.	3846 G	3830-I to 3846-G
Cutting-off	Alun. Elas.	6660 4	6646-5 to 6660-4
Internal	Alun. Vit.	3860 J	3846-K to 3860-H
Stellite			
Snagging	Alun. Vit.	30 O	30-O
Cutting-off	Alun. Elas.	6646 5	6646-5 to 6660-5
	Alun. Rub.		30-36
Stove Parts (Cast Iron)			
Snagging	Crys. Vit.	24 S	24-U to 30-S
Fitting and Mounting	Crys. Vit.	30 S	30-S
Notching	Alun. Rub.	24	24
Grinding Out Cover Holes	Crys. Vit.	30 U	24-U to 30-S
Surfacing Tops Automatic Machine			
Roughing	Crys. Vit.	36 P	30-Q to 36-P
Finishing	Crys. Vit.	80 P	60-R to 80-P
Tape			
Fluting	Alun. Rub.	70	60-70
Sharpening	Alun. Vit.	46 M	46-N to 80-M
Tools (Lathe and Planer)			
Light (Off-hand)	Alun. Vit.	46 N	46-P to 60-L
Heavy (Off-hand)	Alun. Vit.	30 O	24-P to 30-O
Using Large Wheels	Alun. Sil.	24 P	24-P
Automatic (Cup Wheel)	Alun. Vit.	24 L	24-N to 30-L
Automatic (Straight Wheel)	Alun. Sil.	46 M	46-M
Tubes (Steel)			
Cutting-off	Alun. Rub.	36	36-60
Tungsten Rods			
Cutting-off	Alun. Rub.	90	90
Valves (Automobile)			
Grinding Seats	Alun. Vit.	60 N	60-O to 80-M
Cylindrical Grinding Stems	Alun. Vit.	6646 M	6646-M
Valve Tappets			
Cylindrical	Alun. Vit.	6646 L	6636C-M to 6636C-L
	Alun. Vit.		6646-M to 6646-L
Welds			
Cleaning	Alun. Vit.	24 Q	20-S to 36-Q
Worms			
Grinding Threads	Alun. Vit.	6636 K	6624-M to 6636-K
	Alun. Vit.		3824-M to 3836-K
Wrenches			
Snagging	Alun. Vit.	24 Q	16-R to 24-Q
Surfacing	Alun. Vit.	24 Q	20-Q to 46-O
Wrought Iron			
Snagging	Alun. Vit.	20 R	16-S to 24-Q

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GRITS and GRINDS

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*Alundum
Safety Tile*



Grits and Grinds

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Making Factory Floors and Stairs Safe for Workmen

The architects and engineers whose work is largely in the public building or public service corporation field have long recognized the problem before them of providing safe walking surfaces, particularly on stairs, ramps, and places where the danger of slipping is great and foot traffic heavy. It requires but very little argument to convince those in charge of public buildings, the factory owner, de-



**Alundum Tile Installation at the Buick Plant
Flint, Mich.**

partment store owner, the safety engineer, and insurance companies that there is a tremendous waste through compensation, hospital, medical, and other expenses because of slipping and tripping accidents. This menace is of vital concern to corporations and owners of large buildings and should have careful consideration by every factory management. The architect and the engineer have been factors in reducing this economic waste by providing slip-proof walking surfaces, but it was not until the development of Alundum Safety Tile that they had a suitable material—one that combines everlasting

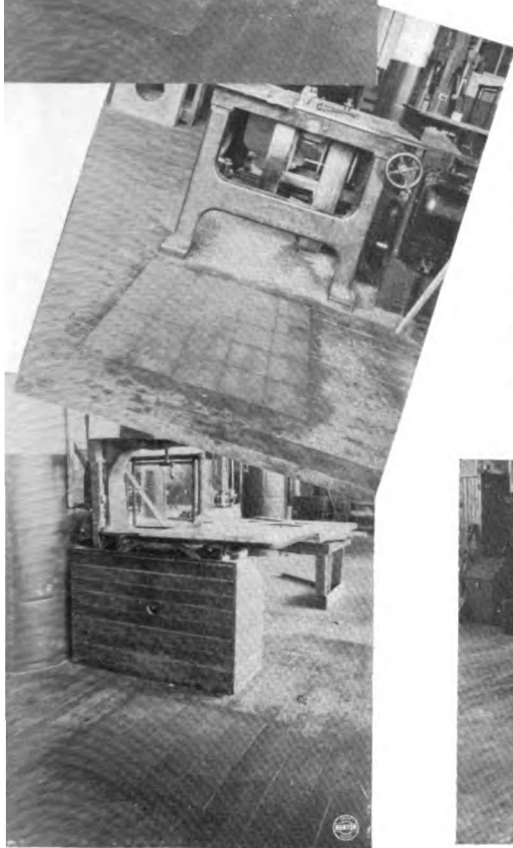
durability with slip-proof effectiveness and architectural attractiveness.

But it is not the purpose of this article to emphasize the advantages of Alundum Safety Tile as it may serve to help the architect solve his problem, but rather to present to the manufacturer the opportunities for making his factory conditions more safe for employees.

Alundum Safety Tile is furnished with a rounded nose for stair treads. Whether the stairs be concrete, wood, or metal, the tile is set in flush with the rest of the step. It is always slip-proof. Neither wear, oil, grease, nor dirt destroys its slip-proof effectiveness. The nose does not wear smooth. There are no grooves nor corrugations to catch dirt or to trip on. It is desirable in connection with any floor where there is danger of slipping—such places as ramps, elevator landings, entrances to buildings, tunnels leading from one factory building to another, and in front of dangerous machinery. Particular emphasis is placed on the practicability



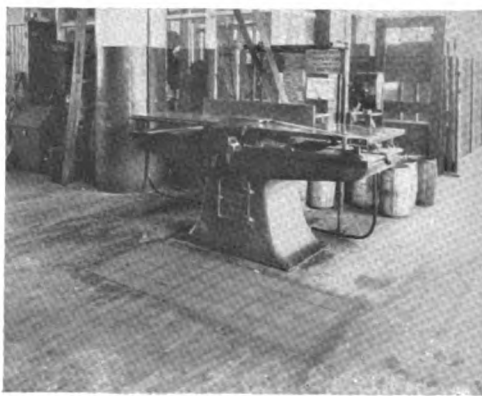
**Joseph & Feiss Co. Factory, Cleveland
Alundum Tile**



of Alundum Safety Tile as a flooring before electrical apparatus, particularly switchboards and starting panels and as flooring in transformer houses and substations. We are showing in this issue just a few of such applications, enough to suggest to each works manager and safety engineer places where he can see the desirability of making similar installations.

For the benefit of those who are unfamiliar with the product, the way it is manufactured, and the reason for its durability and slip-proof effectiveness, let us explain briefly.

It consists of two materials, a scientifically developed electric-furnace product, known by the trade-mark "Alundum," which is bonded with a clay product by formulae resulting from the long experience of the manufacturers in the production of vitrified grinding wheels. The wearing qualities of the vitrified grinding wheel and its sharpness due to the abrasive grain are recognized by every worker in metals. Alundum Safety Tile is produced by the same general process, and the manufacturers have the benefit of a long experience and exhaustive research and experimentation with electric-furnace abrasives and bonding materials. The process is not new and untried. It is manufactured, tested, inspected, and packed with the same degree of accuracy and carefulness as the abrasive products turned out



Showing how operators of dangerous machines are safeguarded by Alundum Safety Tile Flooring

GRITS and GRINDS

at the Norton plant. It is produced by a formula which insures a bonded hardness which has been found to be the most satisfactory all around as regards wearing qualities and slip-proof effectiveness. It provides a flooring which does not have to be replaced. After years of service the wear from foot traffic is practically negligible. The cost of maintenance and replacement are out of consideration.

It has already found its place in the modern factory building on stairs and ramps and particularly where grease and

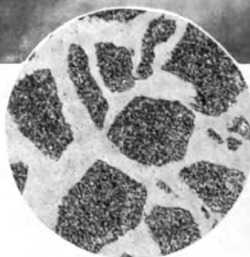


How the Tile is Used at the Detroit Edison Co. Plant

oil make walking dangerous. It has found its place where the operator of dangerous machinery is obliged to shuffle his feet around or take a leaning, pushing position when operating the machine. A point to be remembered is that neither shavings, soapy water, grease, nor oil has any effect on the safety factor. Any one interested in the strength or resistance to impact of the Alundum Safety Tile will be furnished a verbatim copy of physical tests made at Columbia University before the tile was widely introduced.

The Norton engineers will submit on application specifications showing the proper method of installing the tile under any set of conditions.

[4]



**An Alundum Terrazzo Ramp—
Joseph & Feiss
Co., Cleveland**

Aggregates for terrazzo, made of the same material and by the same process as Alundum Safety Tile, offer a means of permanently covering floors, corridors and concourses safely and economically.



**Elevator Landing, Newcomb-Endicott
Building, Detroit**

[SEPTEMBER-OCTOBER, 1921]

Steel Billet Grinding

By R. H. CANNON

When molten steel is poured into an ingot mold, there are almost always a few flaws in the ingot after it has cooled. Some grades of steel are more troublesome than others in this respect, but, in spite of the greatest care in pouring and cooling, it seems to be next to impossible to produce a perfect ingot. There will be checking, blow holes, slivers caused by splashes

advantage by a chisel, but for the harder ones it is necessary to use a grinding wheel. It will cut high carbon and high speed steel more efficiently than any other tool.

A grinding room or "cleaning room" as it is sometimes called should be equipped with a number of swing-frame machines. This type of machine is the only practical one for handling billets. While all swing-



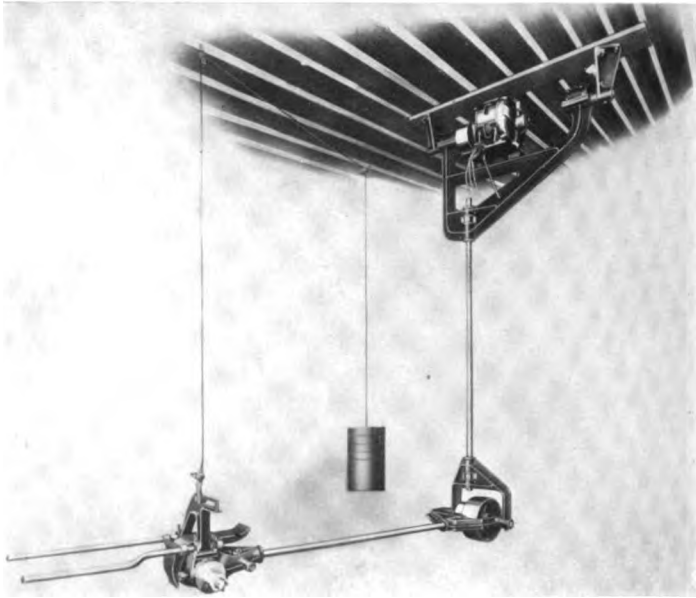
Row of Swing Frames Cleaning Nickel Steel Billets

on the side of the mold, slag inclusions, piping, etc. Some of the blow holes become oxidized as do cooling checks and slivers, and these defects cause seams in the steel which cannot be welded together by reheating and working. Unless removed by mechanical means they will persist down to the finished product.

Seams are usually removed when the steel is in the form of a billet and there are two methods of accomplishing it: by the pneumatic chisel or by the grinding wheel. The softer steels can be handled to good

frame machines may appear to be of the same general type to the casual observer, to those who have seen a large number of billet grinding rooms there are certain very important differences. Let us point out certain features which should be insisted upon when this part of the equipment is being selected.

The pulleys and belts should be large enough so that there will be a minimum of slippage. Especially on the vertical belt with a rather small pulley at the bottom there is likely to be a great loss of



**Swing Frame Machine with Wheel Mounted on the End of the Spindle—Made by
Safety Emery Wheel Co., Springfield, Ohio**

power when too heavy pressure is being exerted between the wheel and the work. To do away with this difficulty pulleys and belts should be generous in width, depending of course on the diameter and width of the grinding wheel. The pulleys should be large enough in diameter. The most common type of swing-frame machine is run from a countershaft and is suspended from the ceiling as shown in figure 1. The weight of the wheel head is taken care of by a counterweight. Another type is suspended by a vertical bar from a trolley overhead while the power is furnished by an individual motor on the end of the horizontal shaft. Thus the motor balances the wheel head. The wheel runs sometimes perpendicular and sometimes by the use of bevelled gears parallel to the horizontal shaft. In either case positive power is insured. It will be found, however, that excessive vibration occurs when wheel head and

motor are so delicately balanced in this way, whereas the counterweight held by a cord passing through two pulleys on the ceiling absorbs a great deal of the vibration. Therefore the more common or counterweighted type is preferable.

Most swing-frame machines have the wheel mounted between the spindle bearings, while one or two manufacturers have the wheel on the end of the spindle. The latter method presents some difficulty in the question of balance, but this can be overcome and a great many concerns are now using machines of this type. Quite a few of them are of their own design. The advantages of having the wheel overhung or mounted on the end of the spindle are obvious at once. If the machine has to be taken apart and the bearings removed to take out the old stub and mount a new wheel an average of at least 20 minutes is consumed. On the other hand a new wheel can be mounted

on the end of the spindle in approximately three minutes. When it is necessary to take the boxes apart, it is a difficult task to adjust them without having them too tight or too loose. The painstaking job of adjusting shims is necessary, and after it is all done a certain amount of dirt and abrasive is bound to have gotten into the boxes, causing excessive and unnecessary wear.

Billets usually come to the grinding room directly after cogging or rolling. An ideal arrangement is to bring the billets in on a lift truck, leaving a loaded body on one side of the inspection table and an empty body on the other. A group of about six grinders will handle that particular load. As each grinder finishes his billet he places it on the inspection table, and the inspector either passes it on to the empty truck body or returns it beside the grinder's bench to be touched up. This system involves a minimum of handling and insures careful inspecting. In some mills the inspecting is done before grinding and a chalk mark placed around each seam. The grinder then confines his attention only to the spaces within these circles. A better practice is to instruct the grinder to remove every seam. He "skins" the billet all over, that is, he removes every bit of scale and can then see each seam plainly. Some concerns "pickle" the billets in acid to remove the scale, but the practice of removing it by the wheel takes only a moment and shows up the seams better than by any other

method. Grinding should be done across the seams, not only because this method is most convenient but because the seams are then plainly visible. If ground longitudinally the grain marks will tend to obscure the seams.

It is impossible to name a grain and grade of grinding wheel which will always give the most satisfactory and most economical results. A good average wheel for high-speed billets is Norton grain 20 grade R Alundum vitrified and for high carbon steel grain 14 grade S Alundum vitrified. Exactly the right grain and grade and the right make of wheel for a particular set of conditions can be determined only after careful test.

Conducting a grinding-wheel test involves careful record keeping and in order to be accurate it should be run for some time, so that a fair average can be credited to each wheel tested. This is to allow for differences in pressure exerted by different operators and different weights of machines, or in other words to allow for the variable effect of the personal factor. It would perhaps suffice to measure the efficiency of the wheels by counting the number of tons of billets produced. It is possible to do this but a more accurate method is to weigh the billets before and after grinding, and determine the number of pounds of material removed by each wheel.

In determining the cost of grinding it will be found most convenient to divide it into three divisions, wheel cost, labor



A Common Type of Swing Frame Grinding Machine

cost, and overhead. The most accurate way to get at wheel cost is first to observe the average diameter at which stubs are discarded. The difference between the volume of the full-sized wheel and the volume of this stub gives the volume of useful abrasive. This has cost the price of a full-sized wheel. Dividing the cost of the wheel by the volume of useful abrasive gives the cost of one cubic inch. A test wheel can now be removed at any time and actual wheel cost computed by multiplying actual wheel wear by the cost per cubic inch.

It is best to remove the wheels at nearly the same diameter if possible. A wheel wears much faster as the size is decreased either because of lower peripheral speed or if the r.p.m. be increased, because each particle is coming into contact with the work more often, so that it is dulled and torn from the bond in a shorter time.

Labor cost can be figured by piece rate or by the hour.

Overhead is reckoned in many shops as so many times labor cost or so much per unit of production. For the present purpose it must be extracted from the Cost department's records as so much per machine per hour, so that it can be reckoned for the life of each wheel. This method also makes overhead a constant figure, that is, independent of the rate of production of the wheel when the workman is paid by piece rate. The overhead *per machine per hour* is sometimes hard to arrive at but is just as important as the other two terms of cost. What is desired is the total investment incurred by the grinding room (including supervision expense) and the number of pounds of steel removed by the wheels of each grain and grade. From these figures we can determine the cost of removing one pound of material. The wheel which removes material at the smallest cost per unit is, of course, the most economical wheel.

Let us see why it is necessary to take into account all these factors. Each de-

partment looks at the problem from a different angle. To the purchasing agent usually the most economical wheel is the one which lasts the longest. To the grinding foreman and the operator the best wheel is the one which cuts the fastest. To the Cost department and the efficiency engineer the best wheel is the one which turns out a unit of production at the lowest cost, all items of cost being considered.

There are a number of items to keep track of and the data sheet illustrated here is suggested for this purpose.

Machine No.
Wheel
Size
Time Mounted
Time Removed
Hours Run
Diameter When Removed
Wheel Wear

Weight of Billet before Grinding	Weight of Billet After Grinding	Material Removed
--	---------------------------------------	---------------------

These figures are then transferred to the general data sheet following and results computed to show the cost per unit ground. This figure is then averaged for the wheels of each grain and grade. Objections are often offered to keeping so much

Wheel	Life in Hrs.	Diam. When Re- moved	Wheel Wear Cu. In.	Net Prod. Lbs.	Material Removed Lbs.
1	36	11½"	194	3,021	72
2	6½	10"	245	789	22½
3	14½	11¼"	203	1,825	62½

Wheel Cost	Labor	Over- head	Total	Cost per Lb. Material Removed
\$4.42	\$12.60	\$18.00	\$35.02	.49
5.58	2.27	3.25	11.10	.49
4.63	5.08	7.25	16.96	.27

Available wheel wear = 314 cubic inches
Overhead = \$.50 per hour per machine
Net price of wheel = \$7.16

[SEPTEMBER-OCTOBER, 1921]



Cleaning Steel Billets

data but it is really not much work. If the workmen are intelligent enough to weigh accurately, each man can keep his own data sheet as shown on page 8. If they cannot be depended on, the inspector can do it. The rest of the computation is not as complex as it may look.

In the example given it will be noted that with the wheel which lasted 36 hours and removed 72 pounds of steel the cost per pound of steel removed is \$.49. This wheel is too hard and too slow cutting to be economical. The next wheel lasting $6\frac{1}{2}$ hours removed only $22\frac{1}{2}$ pounds of material and the cost per pound was \$.49. This wheel was so soft that the particles did not remain in the bond long enough to cut efficiently. Wheel cost was excessive with not enough gain in speed of cutting to make it economical. The third wheel,

while only of medium life, cut at a very fast rate and removed material at a cost of only \$.27 per pound. The saving in a year from finding a wheel which will perform in this way is worth many times the trouble of running the test.

Many foremen argue that all they want to know is how long a wheel lasts and how much it produces. That is not the whole story. What is required is the return which the grinding room is making on the money being invested in it. If the wheel is too hard it cuts slowly and, although the wheel cost is low, the labor and overhead expense are going on just the same and money is being lost. Furthermore, if the wheel is too hard it will heat the work to such an extent that the seams, instead of being ground out, are driven further into the billet. If the

wheel is too soft the wheel cost is excessive, even though production per unit of time is greatly increased. The problem is to find by experiment the wheel which gives the highest return on all items of investment.

There is another problem which to the writer's knowledge has not yet been solved. It is to determine the point at which it is more economical to give up chipping and remove the seams by grinding. It is generally believed that steels of more than .60% carbon and all steels containing tungsten, chromium, and manganese can

be more economically ground. The problem could first be worked out with plain carbon steel and then with the alloys. It would take a great deal of experimenting, but would be very valuable knowledge. In arriving at a conclusion it should be remembered that the grinding wheel removes seams cleaner than does the chisel. The chisel tends topeen the seam over, so that the workman is not sure he has gotten to the bottom of it. In the grinding method the seam is plainly visible until entirely ground out.

Norton Universal Piston Grinding Attachment

The fixture described in this article was designed primarily for the use of re-grinding shops in grinding to size semi-finished pistons. The character of work done by these shops makes it necessary for them to change the set-up of their cylindrical grinding machines each time they grind the pistons of a particular make of car. Under these conditions, the ordinary fixtures used for quantity production would not be satisfactory.

This condition also exists, to a somewhat less extent, in those shops that are engaged in manufacturing all types of pistons for the regrinding shop and garage trade.

The method employed for this kind of work, up to the present time, has been to use a bull center, generally consisting of a special center in the headstock on which rotates a cast-iron cone. This cone centers the open end of the piston, the other end being supported by the tailstock center.

The device heretofore used has been open to several objections. The fixture has generally been designed and built by the local shops and in many cases the design has been such that there has been no provision for taking up wear, neither

have there been very good oiling arrangements. Probably the greatest objection, however, has been due to the fact that in a fixture of this kind there has been no clearance for the wheel to pass beyond the piston at the headstock end. It will be seen that, with the open end of the piston resting against the conical surface of the bull center, there is a space of but about $\frac{1}{16}$ " between the end of the piston and the cast-iron cone. This makes it quite difficult to properly grind the skirt of the



Front View of Attachment to Show Jaws and Driver

Rear View Showing Split Collar for Taking Up Wear



piston without having the wheel interfere with the fixture. If the wheel grinds into the cone a few times, it no longer centers the piston accurately without being ground or turned true and smooth again.

The Norton device, shown in the illustration, possesses the following advantages:

Universal application—can be used on pistons from $2\frac{3}{4}$ " diameter up to the large tractor piston $7\frac{1}{2}$ " diameter

Set-up for different sizes of pistons can be made in about one minute

Ample clearance for corner of the wheel to travel beyond the end of the pistons, without interfering with the fixture

Provision for taking up wear, insuring long life

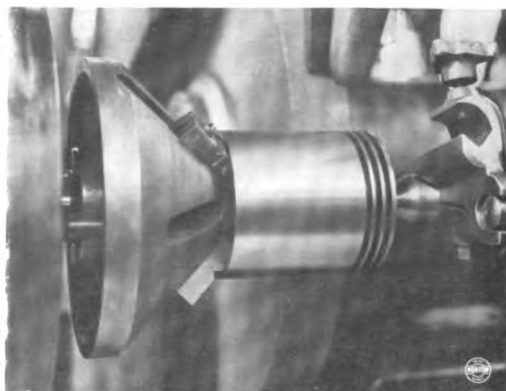
Facilities for proper oiling

Upon examination of the illustrations, it will be seen that the device consists of a dead center on which revolves a cast-iron cone which is driven by the face plate driven pin.

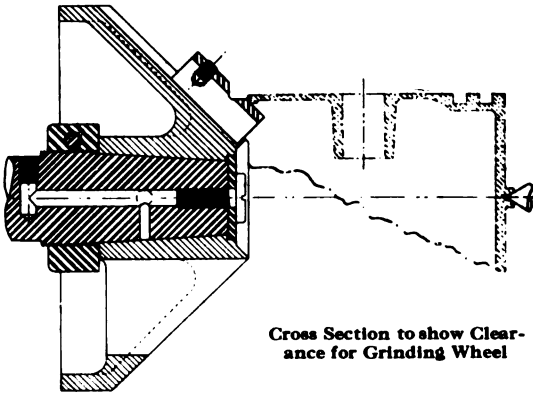
The nose of the dead center provides a hardened taper bearing for the cone. The center is also provided with a split threaded adjustable thrust collar for taking up wear. Generous oiling facilities are provided by means of drilled holes leading from the back of the center to the inside of the bearing.

There are three dovetailed slots milled in the surface of the cone and in these are mounted three slidable jaws. These jaws are split lengthwise and lock in any position by means of a taper screw which spreads them.

The groove in the upper surface of the jaws provides clearance for the wheel to go past the end of the piston without interfering with the fixture. A driving spline is furnished consisting of a small piece of sheet stock screwed to the side of one of the jaws. For De Luxe and other light pistons a driver engaging the inside ribs can be used.



Piston Grinding Attachment with Piston in Place



Cross Section to show Clearance for Grinding Wheel

To set up for a given size piston, loosen the locking screws, tap the jaws until the clearance groove is just below the surface of the piston; then tighten the screws. Accurate setting is not required. The upper surfaces of the jaws are elements

of a cone and no matter in what position they are placed they will properly locate the piston. The only reason for moving them is to provide clearance for the grinding wheel.

The piston is driven by means of a small spline made of a piece of steel screwed to the side of one of the jaws. A shallow slot is filed in the skirt of the piston to engage this spline.

In the case of De Luxe pistons, as the makers do not recommend slotting the skirt, a special driver is furnished which is adjustable for all sizes of pistons.

The fixture described is designed for use on Norton 10" machines.

It can also be used with any standard Norton 10" machine.

Polishing of Flutes of Taps and Reamers

Flutes of reamers, taps, and other similar small tools are not usually polished in regular production work, but are only ground with solid wheels. For that operation Norton Alundum wheels, 2" to 6" in diameter by $\frac{1}{4}$ " to $\frac{1}{2}$ " thick, grains 60 or 80, grades O to Q, have been found satisfactory.

However, some manufacturers do polish the flutes of taps and reamers; and for that work a felt or leather wheel is generally used, unless the work is extra large, when a canvas wheel is better, since it will hold the abrasive better and give greater production. On the smaller sizes a leather wheel is considered best from the cutting standpoint, while it is as good as other kinds for finish. These are made from good quality of oak tan leather. Such wheels should be approximately 6" or 8" in diameter by $\frac{1}{4}$ " or $\frac{1}{2}$ " thick.

Care should be taken to see that the

polishing wheel is true and if necessary it should be turned true before setting up with grain. When this is done a sizing of good glue should be applied and left about two hours to dry. Then two coats of glue and abrasive are put on and left to dry over night. Before using, the grain on the sides of the wheel should be dressed off with a piece of broken grinding wheel, so it cannot cut the edges of the work being polished.

The sizes of wheels and also the grain to use depend largely upon the sizes of the work. For the large work grain 60 or 80 is good, while for smaller sizes about 120 or 150 is satisfactory. If a still better finish is required, grain 200 with Tripoli or oil can be used.

This work is all done free-hand and is considered quite difficult. It sometimes takes even as long as a year to train a man so he will make an efficient polisher of this class of work.

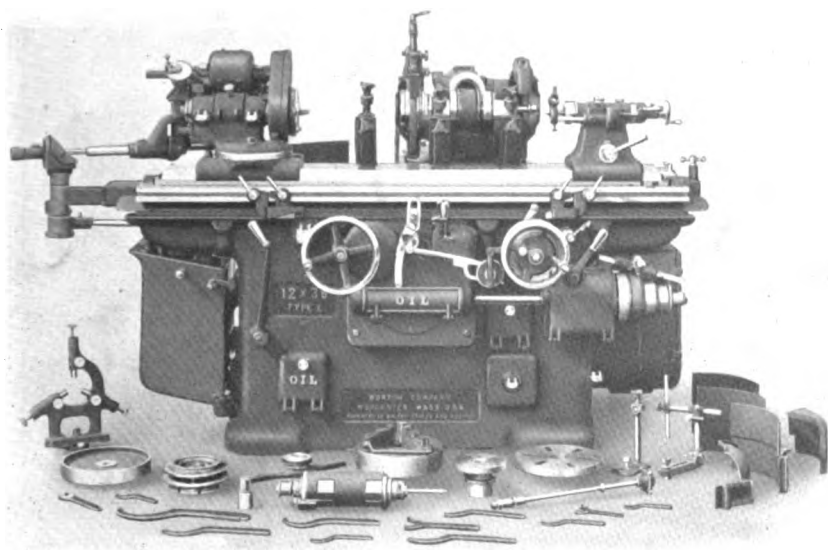
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GRITS and GRINDS

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"MULTIPURPOSE MACHINE"
A Norton Company Universal Grinding Machine



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“Multipurpose Machine”

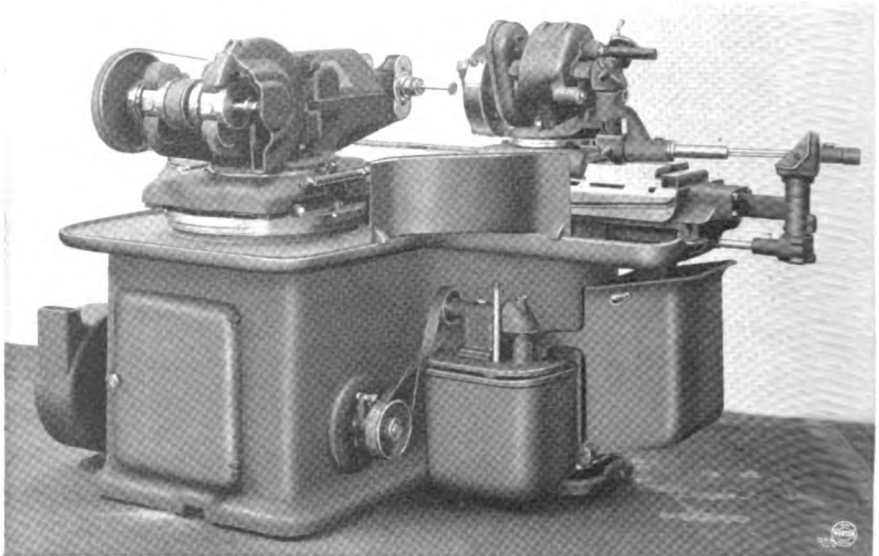
A New Norton Universal Type

When the production man's problem is to install equipment that will efficiently take care of a diversity of grinding operations both on routine and tool work, he will find an easy solution by looking into the capabilities of the Norton universal “multipurpose” grinding machine, illustrated here.

The chief object in designing this machine was to produce one that would be easy to set up and operate and that would

produce accurate work with a minimum maintenance expense. The simplicity of set-up for various operations, such as internal grinding, taper grinding, grinding a bevelled collar, and face grinding, may be seen by the accompanying illustrations.

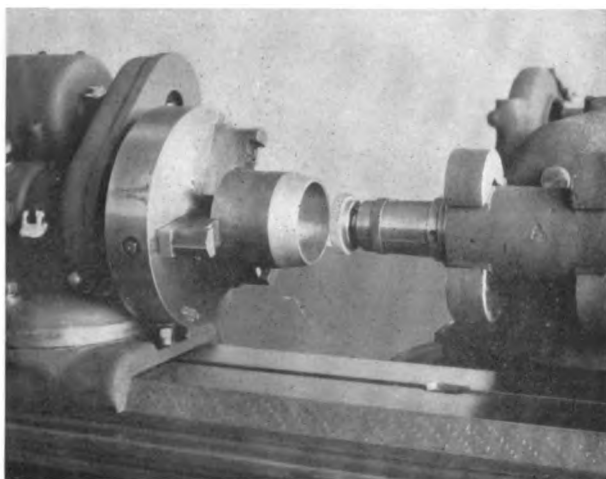
The machine is unique in that it is absolutely self-contained. The necessity for countershafts on the ceiling has been entirely eliminated. The machine as illustrated on the front cover is complete.



Rear View Norton Multipurpose Grinding Machine
(See Front View on Cover)

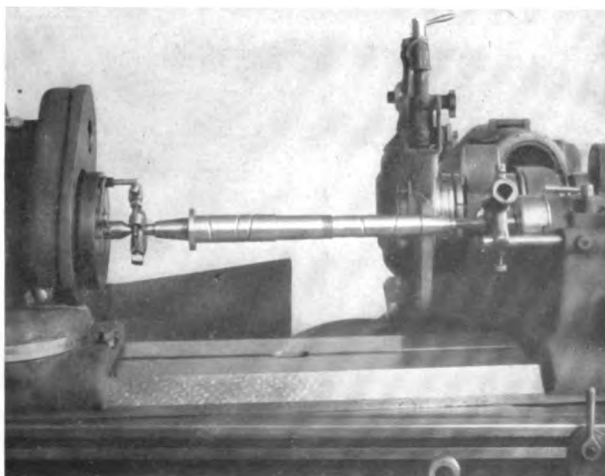
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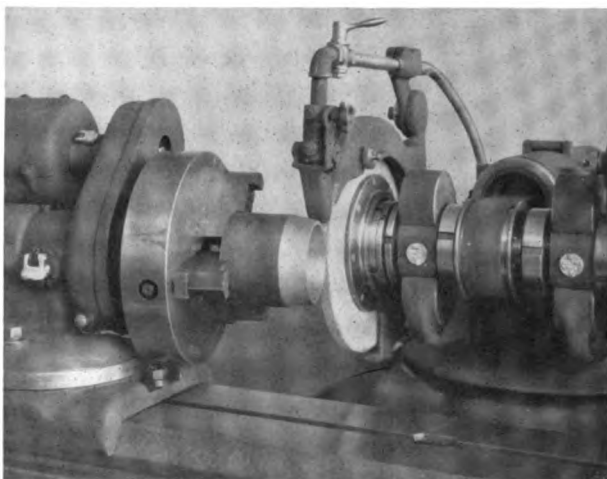
Internal Grinding

The set-up for internal work is very simple. The wheel slide is swivelled 180° from the usual position, driving pulley mounted on wheel spindle, internal spindle mounted in V's and belted to driving pulley. The work is then chucked. No adjustments for height of work or grinding spindle are necessary.



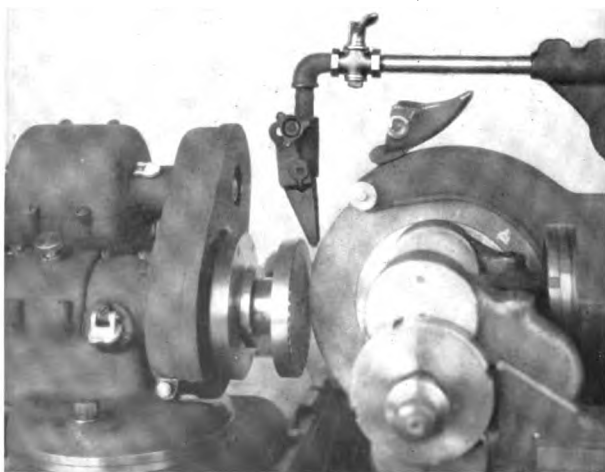
Taper Grinding

Here is shown a tapered portion of a spindle being ground. The taper is 3" to 1", which is the maximum capacity of the machine when grinding on centers.



Grinding a Bevelled Collar

For bevel collar grinding as shown above, or similar work, the headstock is swivelled, the operator being guided by the graduations at the base of the headstock in locating the proper angle.



Grinding the Side of a Saw

The above illustration shows the method of face grinding. The saw is held by means of a draw-in collet and is quickly mounted. Work that cannot be conveniently held by an expanding collet may be mounted in the three-jaw chuck.



It is driven by a single belt from the main drive line or jack shaft, or by a motor placed back of the machine. The main drive pulley on the machine is completely enclosed in the belt guard which may be rotated to any position to accommodate any of these different driving means.

Another important feature embodying new ideas of design is the method of transmitting power from the countershaft in the base of the machine to the wheel spindle, which is done in such a manner that the belt, passing up over idler pulleys, can be twisted to any of the positions to which the wheel head may be set, either for regular or internal grinding. This arrangement of the driving belt to the wheel spindle has made it possible to make the wheel head double-ended, carrying the regular wheel spindle at one end and an internal grinding spindle at the other. The wheel head may be turned through 180° for placing the internal grinding spindle in the operating position, as shown in the rear view, where the regular wheel spindle is at the rear, the wheel being replaced by a pulley that drives the internal grinding wheel spindle by means of a belt.

The wheel head is graduated on the base in degrees, and the cross slide may be rotated to any angle. The belt drive to the wheel head is so arranged with idlers that it is not affected by the swivelling of the wheel head.

A Month in Salt Water

A Norton demonstrator a short time ago found two Norton machines—a 20 x 96" and a 14 x 72"—in use after they had been at the bottom of the New York Harbor for a month or more. Investigation of their history revealed that these machines were on the S. S. "St. Paul" when she sank in New York Harbor. They remained in the salt water for a month; and, when rescued, all that was necessary was to clean off the slush, and the machines had the appearance of new

[NOVEMBER-DECEMBER, 1921]

The drive to the headstock is through a splined shaft; six work speeds, ranging from 53 to 320 r. p. m., are obtained by a bank of gears and sliding key contained in the headstock, all work speeds being entirely independent of the table speeds or wheel speed. The spindle is hollow, so that rods up to ¾" diameter may be passed through. Provision is made so that the center may be rotated or dead, as required.

The machine will swing work up to 12" in diameter and 36" long. Much of the mechanism of the multipurpose machine is the same as is used on Norton machines for cylindrical grinding and is of the same accuracy.

The regular equipment of the multipurpose machine consists of the following:

- 1 special milling cutter chuck
- 1 universal three-jaw chuck, 9½" capacity
- 1 internal spindle
- 3 complete steadyrests
- 1 center rest
- 1 table-type diamond tool holder
- 2 wheel sleeves for wheels 12" diameter and 5" hole
- 1 set of grinding wheels
- 1 set of work drive dogs—1½", 2½", and 4" capacity
- Tooth rests, splash guards, and a complete set of wrenches

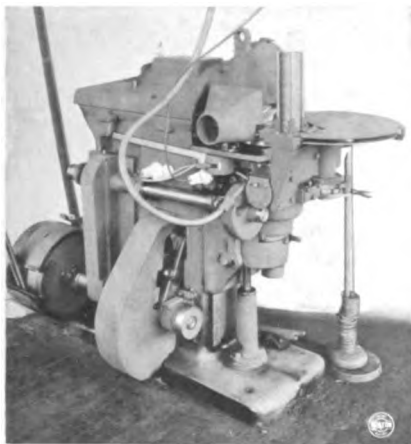
Any one interested in the universal machine may obtain complete specifications on request to the Norton Company.

machines. They were not in the least damaged by rust.

Twenty Years Old

Only recently an order was received by the Norton Company for simple repair parts for machines bearing serial Numbers 1 and 2. These first Norton cylindrical grinding machines were made in the year 1901 and shipped in November and have been in use ever since in the plant of the R. Hoe Company, manufacturers of printing presses in New York City.

[5]



Rear View

in diameter with standard equipment.

A ring is ground at every stroke of the wheel slide and the production is 800 to 1,400 ring sides per hour. In a hand

operated machine, production is dependent upon the skill of the operator in placing and removing rings, and the productive power is wasted when he is bringing or taking away work, or absent from the machine for any reason.

In grinding piston rings on this machine, Alundum wheels have in general been found more satisfactory than Crystolon, even though the material is usually gray iron. This is perhaps due to the necessity for withstanding heavy cuts on the edges of the wheel, and the desire for extra good finish.

The most successful grain combinations are 46 and 50, grades L, M, and N, in Norton aluminous abrasives. No. 66 Alundum seems especially well adapted to this operation, although regular Alundum is sometimes used. Occasionally Crystolon wheels are used in grains 36 or 46 and grades K, L, and M.

Lens Grinding

By R. H. CANNON

[Illustrations by courtesy of American Optical Company, Southbridge, Mass.]

The manufacture of optical lenses involves the use of abrasives in nearly every operation from the time the glass is moulded until it is ready for use. A description of the preparation of an ordinary eyeglass lens will illustrate the various abrasive processes used.

Removing of Surface Bubbles

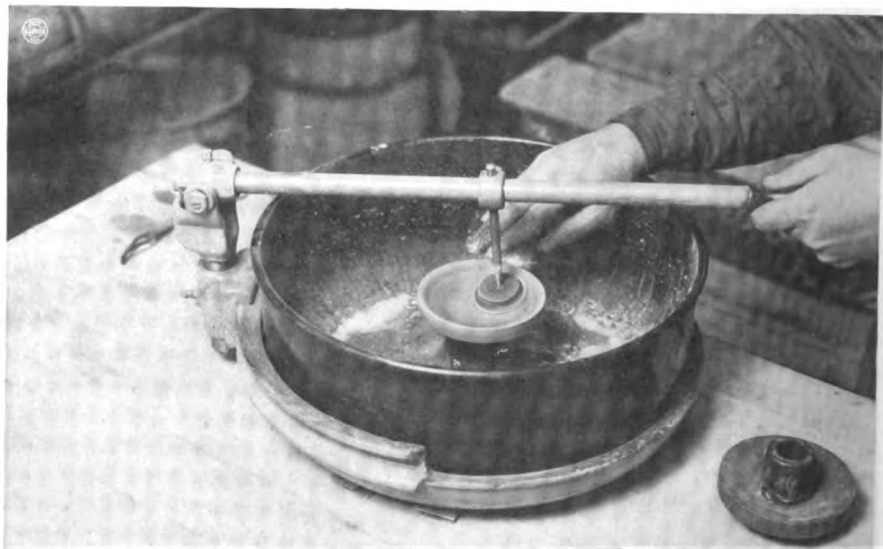
The lens blank, as it comes from the mould, sometimes contains upon its surface tiny air bubbles, in addition to the burrs on its edges. The first grinding operation consists of removing these bubbles by the use of an ordinary floor grinding stand equipped with a silicon carbide abrasive wheel. This is the only grinding operation employing silicon carbide abrasives, all other operations being performed with aluminous abrasives.

Surfacing

The amount of finishing done on the lenses by the manufacturer depends upon the specifications furnished by the retailer. Sometimes the manufacturer finishes both sides of the lens, sometimes only one side, and sometimes leaves both sides unfinished. The lenses are left oversize in thickness, unless finished on both sides, and are always oversize in diameter. The retail optician cuts, finishes, and polishes them to the size and shape desired. The lenses are surfaced by the use of aluminous abrasive grain and polished with rouge, the work being done on either individual hand-operated or automatic machines.

Hand Surfacing Machine

The size of abrasive grain used and the number of operations performed before



the final polishing vary in the different shops. Here is shown an individual hand-operated surfacing machine as used by many opticians.

The hand-operated machine consists essentially of a large metallic bowl in the bottom of which, mounted on a spindle, is a cast-iron hemispherical lap. The lens is surfaced by being attached to an iron block and held against the revolving lap of the proper curvature, motion being given the lens by means of a vertical post attached to a movable horizontal lever arm.

Preparatory to grinding, the lens blank is cemented to its cast-iron block generally by means of a mixture of tar, resin, and plaster of paris. The mixture is warmed, so that it flows freely; and the blank is pressed in place, care being taken that the lens rests evenly and, therefore, is ground to the same thickness all over. A lap of the proper curvature is selected, placed on the spindle, and revolved at

about 750 r. p. m. By means of the vertical post attached to the horizontal handle, the lens blank is held against the lap, which is covered with a mixture of aluminous abrasive grain and water. During the grinding, the lens is continuously moved up and down the surface of the lap.

The consistency of the mixture of abrasive grain and water is very important. If it is too dry, it will become spread over the lap unevenly, exposing bare spots on the lap and causing scratches. If too much water is added, the abrasive particles will flow too easily and break up the film which is so necessary for good work.

The first surfacing operation is made using No. 80 or 90 grain, the second using No. 150, 180 or 200, and the third with finishing flour, which in some cases is the product of the breaking down of the coarser sizes previously used. This broken-up abrasive is sized by the flotation method and the finest of it used for the



A Battery of Automatic Multiple-Spindle Machines

final smoothing. Some of the large optical manufacturers prepare it after they have used the abrasive on the roughing operations and sell the excess over their requirements to the retailers.

After the operation with finishing flour, a felt pad is fastened onto the cast-iron lap, and the lenses are polished with rouge on the same kind of machine.

Automatic Surfacing Machines

When large numbers of lenses of the same curvature are surfaced by the manufacturer, they are placed in multiple on large blocks and surfaced on a multiple-spindle machine. Sometimes as many as 100 lenses can be fastened on one block and ground on one lap. The diameter of the block and lap depends, of course, on the radius of curvature of the lenses, and hence the number of lenses which can be placed on one block is limited. The smaller the radius of curvature, the fewer can be done on one block.

[NOVEMBER-DECEMBER, 1921]

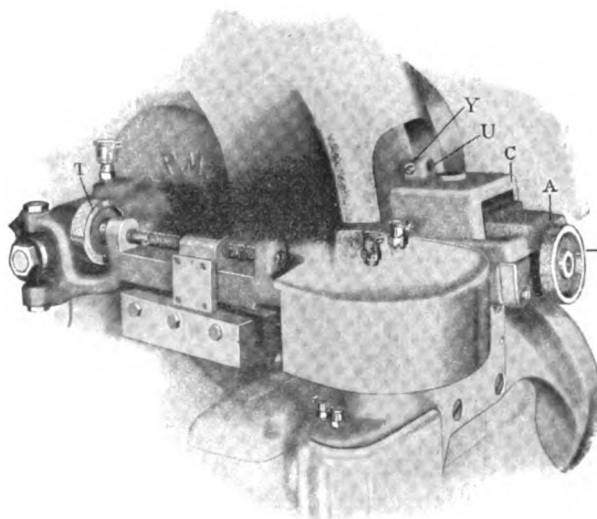
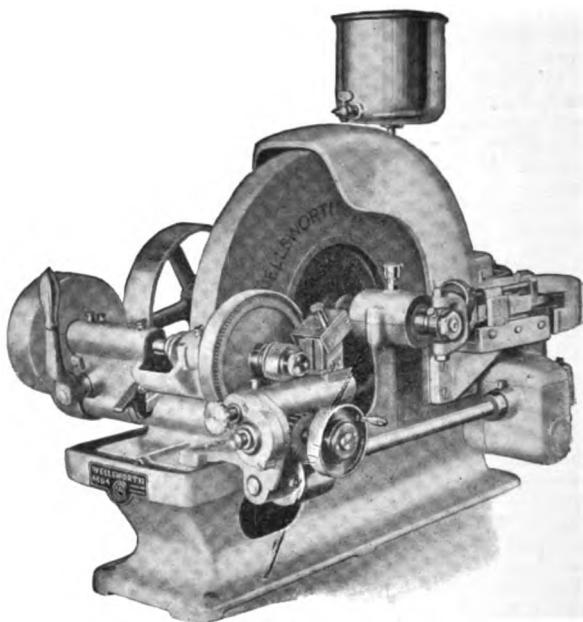
Above is illustrated a battery of automatic multiple-spindle machines. The lenses are cemented to the block (second machine in figure), which is mounted at the top of a vertical spindle and can be rotated. A lap having the proper curvature is selected (the workman in the figure is shown testing a lap for curvature by means of a template) and attached eccentrically to the overhead vertical spindle. On rotating, due to the eccentric attachment, different parts of the lap come in successive contact with the lenses, thus producing lenses of more uniform thickness.

This method of spinning the lenses on the lap is correct for plain spherical lenses, whether concave or convex; but, when the lenses are cylindrical, that is, with one meridian straight and the one at right angles to it curved, or when they are toric, that is, with these two meridians of different radii of curvature, a different method is necessary. In these cases the lens must not spin on the block, and spe-

[9]



**Automatic Machine
for Lens Edging**



**Method of Truing
Lens Grinding
Wheel with Cry-
stolon Brick**

cial machines are used for the many combinations required. In one of them, for instance, the lap revolves while the lens is moved back and forth across it at right angles.

After surfacing, the lenses are polished with rouge, then centered and cut to the

proper size and shape with a diamond tool. This process leaves the edges rather rough and necessitates another grinding operation—that of edging.

Edging

Lens edging is done on a special automatic machine, one type of which is shown



here. The grinding wheel runs at about 1,200 s. f. p. m. and reciprocates slowly from side to side, so that its face will be worn evenly.

The shape of the lens is controlled entirely by the form of a pattern which acts like a cam and touches a contact plate. The length of the lens is obtained from setting an index dial at the proper figure.

The lenses are carefully centered in a centering attachment and then placed in a lens holder attached to the machine. If more than one lens is edged at the same

time, rubber pads are placed between the lenses. The automatic machine produces lenses with straight edges only. If they are required to be bevelled, this is done offhand after the automatic operation. The operator holds the lens between his thumb and finger and lets it spin against the wheel, an operation requiring a great deal of skill and experience to obtain an even bevel.

All that remains to be done after the edging and bevelling is to drill the lenses with a diamond drill and assemble them in the frames.

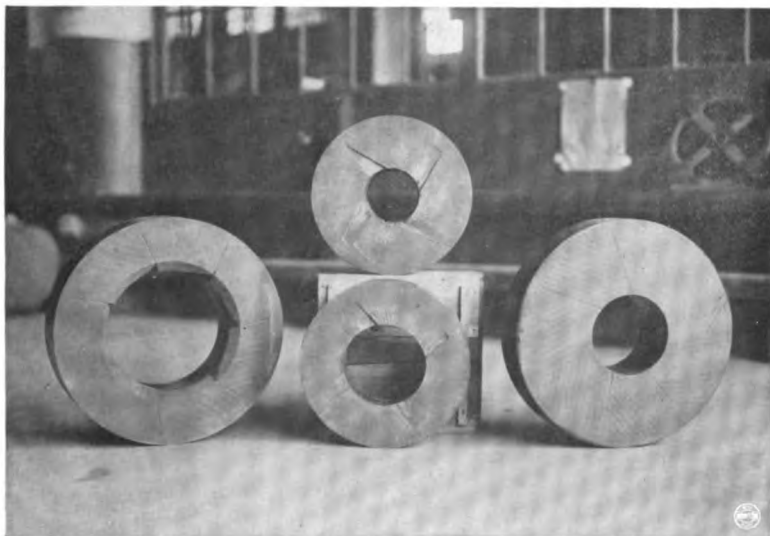
Paint Grinding

By W. W. GREENWOOD

Millstones of natural origin such as the Buhrs or Esopus stones have certain unsatisfactory characteristics from the operator's point of view. They sometimes vary in hardness and are subject to seams or cracks just like other quarried products. For a long time there has been need for stones that are uniform throughout and which can produce a better quality of paint than the natural stones. Alundum millstones were developed to meet this demand. The millstones are made by the vitrified process using the aluminous

abrasive known by the trademark Alundum.

Alundum millstones have a number of physical characteristics worthy of consideration. One property which will appeal to manufacturers of paint is that of the uniformity of the stone, for, being an artificial product, its structure is the same throughout. No hard nor soft spots will be found, and the difficulty of uneven wearing of two stones is thus eliminated. Since this degree of hardness is under control by the process of manufacture, the user may be assured that the mill-



Showing How Paint Grinding Wheels are Grooved

stones obtained through a period of years will not vary. Because of this fact one set of variables in the paint industry, namely, that of the source and quality of stones supplied, is entirely obviated.

Other interesting properties are possessed by these stones. They grind all types of paint and enamels, including fine coach colors. Paints may be ground to a very fine state if desired, and because of the slow wearing of the stone this fineness runs uniform throughout the period of grinding. Thus constant adjustment of a set of stones during the run is not necessary.

This slow wearing results in the face dress remaining sharp from 50 to 100% longer than is the case with the natural stone. A saving in the labor and time expended in dressing can therefore be accomplished by the use of artificial stones. Since mills so equipped do not have to be taken down so often, more paint per unit

can be produced than with natural stones.

These millstones are unaffected by water or acids.

Since every step in their manufacture is under control, Alundum millstones are supplied molded to size to fit the customer's mill. The grooves and furrows of any type dressing are cut in them before firing, and therefore no labor need be expended in mounting them except that done in accommodating the two grinding faces when first brought together, so that the stones run true.

The photograph shows some of these millstones and gives an idea of how the face dress is applied before shipment. When they have worn so that it is necessary to redress them, they are handled in the same manner as the natural stones. Either pick, air chisel, or equipment whereby grinding wheels are used, may be employed for this purpose with satisfactory results.

Polishing of Flutes of Taps and Reamers

Flutes of reamers, taps, and other similar small tools are not usually polished in regular production work, but are only ground with solid wheels. For that operation Norton Alundum wheels, 2" to 6" in diameter by $\frac{1}{4}$ " to $\frac{1}{2}$ " thick, grains 60 or 80, grades O to Q, have been found satisfactory.

However, some manufacturers do polish the flutes of taps and reamers; and for that work a felt or leather wheel is generally used, unless the work is extra large, when a canvas wheel is better, since it will hold the abrasive better and give greater production. On the smaller sizes a leather wheel is considered best from the cutting standpoint, while it is as good as other kinds for finish. These are made from good quality of oak tan leather. Such wheels should be approximately 6" or 8" in diameter by $\frac{1}{4}$ " or $\frac{1}{2}$ " thick.

Care should be taken to see that the

polishing wheel is true and if necessary it should be turned true before setting up with grain. When this is done a sizing of good glue should be applied and left about two hours to dry. Then two coats of glue and abrasive are put on and left to dry over night. Before using, the grain on the sides of the wheel should be dressed off with a piece of broken grinding wheel, so it cannot cut the edges of the work being polished.

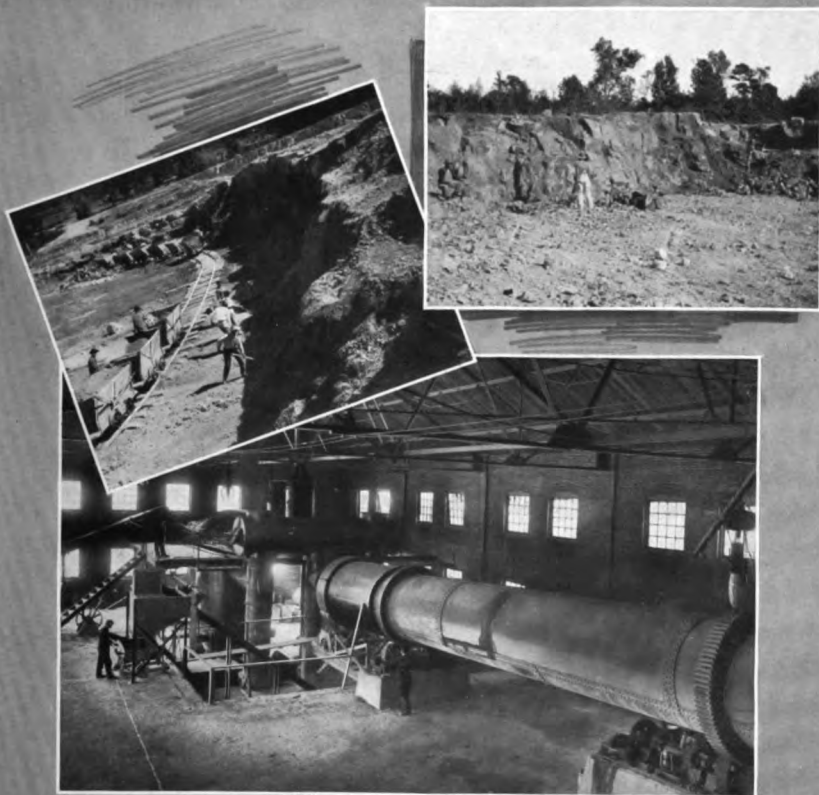
The sizes of wheels and also the grain to use depend largely upon the sizes of the work. For the large work grain 60 or 80 is good, while for smaller sizes about 120 or 150 is satisfactory. If a still better finish is required, grain 200 with Tripoli or oil can be used.

This work is all done free-hand and is considered quite difficult. It sometimes takes even as long as a year to train a man so he will make an efficient polisher of this class of work.

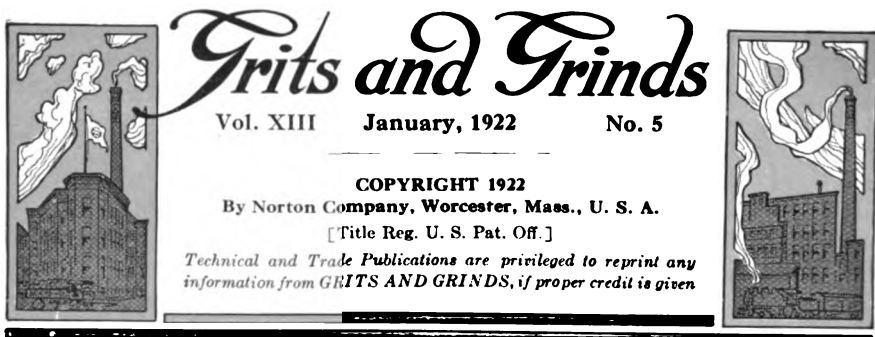
GRITS and GRINDS

January

1922



Bauxite Mines and Rotary Calciner



Series of Articles on Grinding

During the year 1922 we will publish in "Grits and Grinds" a series of articles on the "Theory and Practice of Grinding" prepared by the Norton Company Educational department. While they may impress the shop man who has made a long study of grinding-wheel uses, grinding methods, and conditions as elementary, the articles will be of interest to thousands of "Grits and Grinds" readers who have had less experience in grinding practice and fewer opportunities to acquire detail knowledge of the theory of grinding and its application in the industries.

These articles will contain much information that will be of interest and importance to the machine-shop superintendents, foremen, and grinding-machine operators, and should be preserved. If, at the end of the year, the reader will have his twelve copies of "Grits and Grinds" bound, he will have a series of grinding stories that cover a broad scope and which contain a vast amount of information relating to the manufacture and uses of grinding wheels and grinding practice. A list of the subjects to be covered follows.

[2]

Theory and Practice of Grinding

Subjects

Abrasives
Manufacture of Grinding Wheels
Selection of Grinding Wheels
Theory of Grinding—Precision Grinding
Internal, Plane Surface, and Tool and Cutter Grinding
Care and Safe Use of Grinding Wheels

Application of Grinding in the Industries

Subjects

Application of Grinding in the Automotive Industry
Application of Grinding in the Automotive Industry (Continued)
Application of Grinding in the Agricultural Industry
Grinding as Applied to the Foundry, Steel Mill, and Railroad Industry
Grinding of Small Tools
Grinding as Applied to the Woodworking Tool and Cutlery Industry
Grinding as Applied to the Non-Metallic Industries

[JANUARY, 1922]

Abrasives

History—Development—Characteristics

I. History

Grinding, as it is known at the present time, is not an old art, most of its development having taken place in the last thirty-five or forty years, but the shaping of edged tools was done in prehistoric times. For centuries the only abrasives used in any quantity were those prepared from the natural sandstone, and no articles could be worked with speed that were harder than the constituents of this material. Eighty years ago, there were attempts to improve upon this grinding tool, but little success was met with in the development of the new materials.

Natural Abrasives

Emery and corundum had been known for a long time as hard minerals, and it was quite logical, therefore, that these early attempts at making artificial grinding wheels should be made with these substances. Bonding materials made of a variety of substances for the purpose of holding the abrasive grains together were experimented with. Glue and shellac were tried, silicate of soda was used, but important progress in the making of artificial grindstones was not obtained until the arts of the potter were employed.

In the late sixties, the use of pottery mixtures was tried, and grains of emery were bonded together with the porcelainic materials resulting from heating together clays and fluxes. From this time on, progress in the use of artificial grinding wheels was rapid, and the art of grinding grew by leaps and bounds.

In this lecture, no attempt is being made to describe exhaustively the sandstone from which grindstones were made, nor will any further description of emery and corundum be made than to say that their grinding ability, or abrasive property, is dependent on their chief constituent—crystalline aluminum oxide.

Emery was obtained from Eastern coun-

tries—Asia Minor, Greece, and Turkey, and from western Massachusetts and eastern New York. Corundum came at an early date from India, but later it was found in Canada and in the southern part of the United States, principally in the states of Tennessee, Georgia, and North Carolina, and in many other countries.

Variation in Natural Abrasives

In using these minerals, difficulty was experienced almost from the start in the fact that the shipments from one locality were not like those from another, nor did two succeeding shipments from the same locality always check each other. The consequence was a variation in the quality of the grinding wheels produced, which became more serious as grinding became more refined. These difficulties led to experiments for the production of artificial abrasives which would not have the variable qualities present in the natural minerals.

II. Artificial Abrasives

Early Experiments in Artificial Abrasives

An early experimenter along these lines was Mr. Edward G. Acheson, an electrical engineer who conceived the idea of making hard materials by smelting coke with clay. He actually produced in this manner small glistening crystals which later turned out to be silicon carbide. From this imperfect experiment, using impure materials, an important abrasive has developed.

The raw materials of today differ from those of the original experiment, purer forms of carbon and pure silica now being required.

Another set of experiments taking place at the time the use of the electric furnace was being introduced was performed by a set of experimenters working under the name of the Ampere Electrochemical Company in some little sheds



adjoining the Crocker-Wheeler Electric Company's works at Ampere, N. J. These men also were looking for hard materials and made the logical attempt to duplicate in chemical composition the natural minerals emery and corundum. To do this, they searched for an available raw material and found it in the mineral bauxite, which consists essentially of aluminum oxide in the amorphous or non-crystalline condition. The bauxite was melted in the electric furnace; and there was produced an exceedingly hard material which had properties similar to those of emery and corundum, and which could, from a knowledge of the raw materials and furnace methods, be produced in a uniform grade.

This gives in brief the reasons for the development of the present electric-furnace artificial abrasives which have attained commercial prominence at the present time.

The student will find descriptions of the various forms of sandstone, emery, and corundum in text books on mineralogy, and it is not deemed necessary to introduce further descriptive matter of that kind here. In the case of the artificial abrasives, however, descriptions are not as accurate, and on this account details are given of the way in which these abrasives are prepared and the properties which they possess.

1. Silicon Carbide

Composition

Silicon carbide is composed of the elements silicon and carbon, its chemical formula being SiC . The raw materials from which it is made are silica, supplied by a pure glass or silica sand, and carbon, supplied by coke of various grades, principally that from the petroleum industry, on account of its freedom from mineral impurities.

Manufacture

These materials, carefully ground and mixed together and supplied with a small quantity of sawdust to make them porous,

are placed in an electric furnace of the resistance type. These furnaces are large brick boxes oblong in shape, the terminal electrodes being at the ends. The mixture of materials is packed into the furnace, and a conductor of granular coke is led from one electrode end to the other. The mixture is again piled on top of this carbon conductor, and the furnace is ready for operation.

The current passes through the carbon core and produces therein a high but well-regulated temperature. The heat thus supplied to the surrounding mixture brings about a chemical reaction which results in the silicon carbide crystals and a large quantity of carbon monoxide gas. The presence of sawdust is for the purpose of permitting this gas to escape so that it will not explode within the mass itself.

Zones within the Furnace

The resulting product is in the form of a cylinder, in the center of which is the original granular carbon core surrounded by a mass of loosely knit crystals composing the commercial product. Adjoining this, on the outside, is a layer of a material called firesand, which consists of a partially converted mass containing crystalline and amorphous silicon carbide, and small quantities of the mixture ingredients. Still further outside are layers of the original unconverted raw materials. This product was made originally by its inventor, Mr. Acheson, in a small plant near Pittsburg.

Manufacturers and Trade-Mark Names

At the beginning of the electric power developments in Niagara Falls, in 1895, a company was organized called the Carborundum Company and the manufacture taken over by them. It has developed into a large industry; but the original patents have expired, and there are other manufacturers now of this product in addition to the Carborundum Company. They include the Canadian Aloxit Company, Ltd., a subsidiary of the Carborundum Company, with plants



Crystolon Furnaces Charged and Ready for the Turning on of the Electric Current



Crystolon Furnace Burning. Gases Formed due to Reactions within the Furnace Burning as They Escape Between the Unset Bricks

at Niagara Falls, Ont., and Shawinigan Falls, Que.; the Exolon Company, with a plant at Thorold, Ont.; and the Norton Company, with its plant at Chippawa, Ont.

From time to time crystalline silicon carbide has been manufactured in various European countries, but in most cases the war caused an interruption of production. However, the material is now being made in Norway, Sweden, Austria, Switzerland and Germany.

The trade-mark names adopted include: Carbolite, Carbolon, Carborundum, Carbosolite, Carbowalt, Corex, Crystolon, Electrolon, Gresolite, Maxf Carbo and Sterbon.

2. Aluminous Abrasives

Bauxite

The steps in the development of aluminous abrasive are somewhat similar to those of silicon carbide. The raw material, previously indicated as being bauxite, occurs in various parts of the world, it having been discovered and named in southern France. There are deposits widely scattered, but those of principal interest are in France and in the southern part of the United States: namely, in Arkansas, Georgia, Alabama, and Tennessee.

Bauxite, as it occurs in nature, is always accompanied by combined water, which it is found necessary from the standpoint of economy to remove before the ore is treated in the electric furnace. Bauxite contains, in addition to aluminum oxide, varying percentages of the oxides of silicon, iron, and titanium, and the amount and proportions of these impurities govern to some extent the qualities of the resulting product.

It is therefore customary to smelt, in the electric furnace, bauxite to which have been added various purifying agents, and the result is almost always a product of a higher alumina content than the original ore.

Manufacture of Aluminous Abrasive

The furnaces in which this work is carried on are, in practically all cases, arc furnaces. There are numerous modifications, but the one used by the largest manufacturer consists of a sheet-steel shell practically cylindrical in shape, but slightly larger at the bottom than at the top. This shell has no lining. It is placed on a carbon bottom supported on a set of wheels, and on the shell during its operation is played a continuous spray of water. The water chills the layer of material adjoining and forms an effective lining.

Carbon electrodes of opposite potential are suspended in the shell, and the smelting takes place as a result of an electric current, which arcs from one electrode



**Electric Arc Furnaces
and Cooling Floor,
showing Alundum
Pigs Before Being
Broken Up**



to the surface of the molten mass, passes through the latter, and arcs back from the surface to the opposite electrode. The temperatures are high, and the mass is extremely fluid. The impurities, having been reduced in most cases to the form of metal, settle through the charge and collect in a button at the bottom.

The results of the original experiments at Ampere, N. J., were of so much interest to the Norton Emery Wheel Company that it arranged for an additional quantity of the material to be produced, which was done at Republic Falls, Me.

Still larger quantities being required, the manufacture was transferred to Niagara Falls, and here several hundred tons were prepared for trial in the manufacture of grinding wheels. These experiments succeeded so well that the Norton Emery Wheel Company built a plant at Niagara Falls, and the commercial production of the product started in 1902.

Uniformity of Product

As has been stated before, bauxite is of variable composition. It follows that unless great precautions are taken the resulting abrasive may be of variable composition and properties. It therefore

becomes a matter of skill to bring about that quality which was so urgently needed when these experiments were started, namely, uniformity in the product day after day. This has been so successfully accomplished that, not only can duplication be assured, but variations can be made deliberately, for there are certain places where variable qualities in the aluminous abrasives are desirable.

Manufacturers and Trade-Mark Names

The Norton Company, which has succeeded the Norton Emery Wheel Company, no longer controls the basic patents, as these patents have expired. A number of other manufacturers of this product have appeared in addition to the Norton Company, the largest producer, which has plants at Niagara Falls, N. Y., and Chippawa, Ont. The manufacturers in addition to the Norton Company are the Canadian Aloxite Company, a subsidiary of the Carborundum Company; the Exolon Company; the General Abrasive Company; and the National Abrasive Company.

Trade-mark names for aluminous abrasives are numerous: Adamite, Alowalt,

Aloxite, Alundum, Borolon, Calceinite, Carbo-Alumina, Combin, Corem, Corolox, Corowalt, Dessus, Diamantite, Electrit, Jeddite, Lyonite, Maxf M, Maxf Sapphite, Oxaluma, Rebite, Rex, Rexite and Sterlith.

III. Properties of Abrasives

To the thoughtful student, there will probably present itself the question, "What reason is there for having two abrasives of such widely different types?"

In the earlier days of grinding, there was no very good reason for having two such abrasives, but with an increased knowledge of what abrasives are called upon to do came a more exact knowledge of the specific places where one abrasive would do better work than another.

Essential Properties of an Abrasive

An abrasive is a tool which cuts or wears away a material softer than itself. The properties which make it useful are, among others, hardness, toughness, and nature of fracture

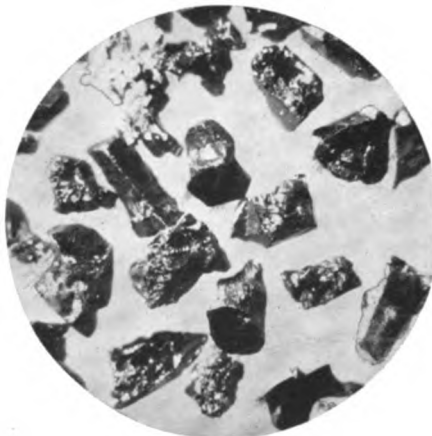
Hardness is defined as the limit of resistance of a material offered by its particles or molecules to a change in their relative positions. Toughness is defined as that property of a body by which it retains strength under strain. By "nature of fracture" is meant the condition of the surface left after the breaking off of

particles. All of these properties have to do with the efficient use of abrasives in grinding wheel form.

Characteristics of Silicon Carbide and Aluminous Abrasives

Silicon carbide is of great hardness, but of slight toughness. It has well-defined cleavage so that, in breaking, its particles present an angular form. It has been found best adapted to the grinding of materials which have, among other properties, low tensile strength.

Aluminous abrasive is of great hardness, but slightly less, probably, than that of



Crystolon Abrasive



38 Alundum Abrasive



Regular Alundum Abrasive



silicon carbide. It is possessed usually and normally of a higher degree of toughness than silicon carbide. Aluminous abrasive is usually of a crystalline form such that its particles present a broken and irregular fracture. It has been found that this abrasive grinds best those metals and materials which have, among other properties, high tensile strength.

Moh's Scale of Hardness

Lest there should be some misapprehension about the description of the hardness of these two materials, the student is reminded that there is a scale of minerals known as Moh's, which ranges from 1 to 10, each number having assigned to it a natural mineral. Number 9 is natural corundum, and No. 10 is the diamond. It is generally believed that there is a greater difference by far between No. 9 and No. 10 than in the range from No. 1 to No. 9. No natural minerals can be found to intersperse between No. 9 and No. 10, and so there is some uncertainty as to the relative hardness of artificial abrasives.

Modification of Characteristics Due to Manufacture

Silicon carbide can be varied in its properties but little, and its excellence lies usually in the purity of the materials which have been used in making it and the care in its preparation. By taking unusual precautions, silicon carbide of great purity can be prepared. While it differs considerably in appearance, there is little improvement in abrasive properties.

With the aluminous abrasive, modifications can be produced. A change in crystal size may be desirable for the grinding of special metals. The ordinary aluminous abrasive contains large crystals, sometimes as large as 1" in diameter. When abrasive grains are prepared from this material, these large crystals are broken, and the grains are, therefore, fragments of crystals.

It is possible to decrease this crystal size so that abrasive grains contain one or several crystals, which make the material

useful for specific work. This may be done in a variety of ways. One is by the introduction of a small quantity of alkali which has the property of causing crystallization to occur in a predetermined scale of size. Another method is to pour the abrasive out in a thin layer in order that it may cool quickly. Other methods of producing this effect are by the addition of the impurities of the bauxite or by leaving them in, or by the addition of other oxides such as lime and magnesia.

One of the most important modifications is that made from commercially pure aluminum oxide. This aluminum oxide contains as its only impurity a small quantity of alkali. When this is melted down, the alkali tends to vaporize at the moment of solidification, which produces a honeycomb effect. The resulting abrasive, therefore, has a relatively weak structure, and is very efficient for certain types of grinding.

Nothing further is being said of the applications of these modifications of aluminous abrasives to grinding, for this subject will be covered in another lecture.

Our knowledge of the compositions, variations, and properties of artificial abrasives is increasing. These abrasives are difficult to work with because of the high temperatures required to make them and the hardness which increases the difficulty of working them. A variety of tools have been put to the task, however, and among them no other is of greater importance than the petrographic microscope, which has taught us all we know concerning the crystalline structure.

Various properties of the abrasives are being measured, and we are beginning to correlate these properties with those of the metals upon which the abrasives work.

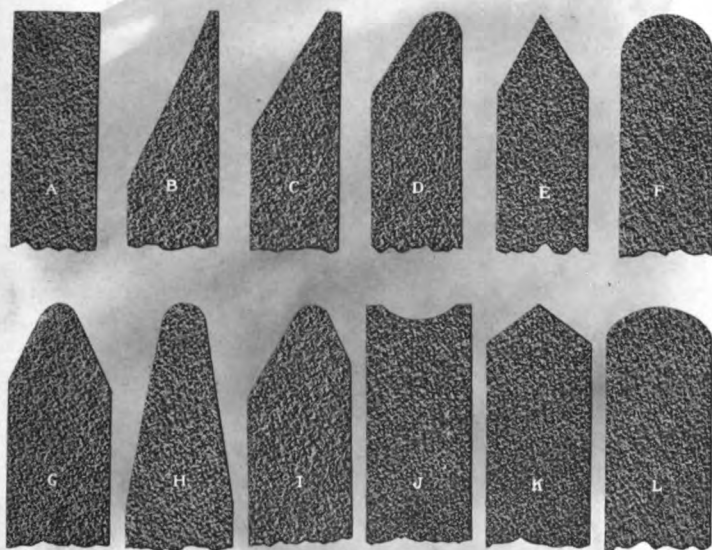
Experiments are continually going on in many places looking toward improvement of the present abrasives and the development of new ones and, considering the quality of the work performed, it would be surprising if unusual developments did not take place within the next few years.

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GRITS and GRINDS



Standard Shapes of Wheel Faces. Wheels May be Trued to
Any Desired Shape

February, 1922



Grits and Grinds

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No. 6

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Manufacture of Grinding Wheels

I. Natural Grindstones

Natural abrasive wheels are made from sandstones, deposits of which are found in most parts of the world. Nearly all of the natural grindstones produced in the United States are made from the sandstone found in Ohio and Michigan, by far the larger part being made from the so-called Berea sandstone of Ohio.

The first grindstones were rough hewn by hand. A stone of the proper size was broken from the quarry, split to proper thickness, and fashioned by hand tools into an approximately circular shape. A square hole for mounting, cut in the center, completed the manufacturing operation.

Mechanical means were soon devised for cutting the stone into circular shape, and the first machine-cut stone was made by John Baldwin of Ohio in 1833. In the present methods employed, the stone is cut to proper size in its natural bed, by means of a circular channeling machine. The block is then pried loose, split to proper size, and the separate stones finished.

Natural grindstones are comparatively inexpensive and have been largely used in the glass, cutlery, and axe industries. In shop production work they are gradually being replaced by the artificial wheels, because the latter can be operated at a much higher speed and can be made to specifications. Grindstones undoubtedly will still be used where production is not the important part, as in the farming in-

dustry, and where the work required warrants but little investment.

II. Artificial Abrasive Wheels

The following description of grinding wheel manufacture applies equally well to wheels made of silicon carbide and aluminum oxide abrasives.

Preparation of Abrasive

Crushing and Rolling

After the abrasive ore has been rough crushed and the metallic segregations, crust material, and other foreign material have been picked out, it is delivered to the abrasive mill, in pieces of varying size, the largest about 6" across, for crushing and sizing. The lumps are first fed into powerful jaw crushers set to crush to $\frac{3}{4}$ " and finer, and then through a series of rolls which reduce the abrasive to a range of sizes suitable for use in wheels, sharpening stones, and refractories.

Magnetic Separation

Between the crushers and the rolls, the ore is passed over screens to remove the smaller sizes as fast as they are produced, in order to avoid useless handling and the further reduction of the finer portion. During the crushing and rolling, the ore is conveyed from one machine to another by elevators and chutes. Magnetic separators are introduced into this system to remove iron compounds.

Washing and Drying

Before the material leaves the abrasive mill, it is passed through washers which remove whatever dust, dirt, or other foreign material that may have been introduced in the handling or crushing. The abrasive is dried in continuous rotary driers, which consist of a large steel shell, shaped like a steam locomotive boiler and containing heating pipes. These driers are so mounted that the abrasive moves by gravity through the shell and falls out at the lower end.

Grain Sizes

The grains are then accurately graded by being passed over a series of pulsating or vibrating screens. The grain sizes regularly produced are designated by the following numbers:

8	20	60	120
10	24	70	150
12	30	80	180
14	36	90	200
16	46	100	

Each designation refers to the "mesh" of the screen through which the particular grain passes. For example, number 24 grain is that which passes a screen having 24 meshes or apertures per linear inch, or 576 apertures per square inch, and is retained on a screen having 30 meshes or more per linear inch. Number 30 grain is that which passes a 30 mesh screen and is retained on a 36 mesh or finer screen. Sizes finer than number 200, commonly referred to as "flours," are separated hydraulically and are variously designated by different manufacturers.

Abrasive Inspection

When the abrasive grain comes from the screens it is carefully inspected to insure that it conforms to the standard grain sizes, that the magnetic content is within the required limits, and that it complies with other specifications. Having passed this inspection, the grain is the finished product of the mill and is taken to the abrasive

storage or directly to the mixing department of the wheel plant.

Types of Bond Mixtures

Grinding wheels are made from the sized abrasive grains by cementing or "bonding" them together into shapes for mounting upon grinding machines. The bond mixtures are of four general types: vitrified, silicate, elastic, and rubber.

The making of wheels by the vitrified process will be described in some detail. The operations which are common to others, as well as the vitrified process, will be described under the vitrified process, but not repeated under the description of the other processes.

1. Vitrified Process

Bond

Probably 80% of the grinding wheels manufactured are made by the vitrified process.

The bond is composed of suitable clays and fluxes which are mixed with the desired abrasives. The base of all bonds for vitrified wheels is feldspar, or a fusible clay to which is added a refractory clay to decrease the fusibility of the bond. The clays to be used are first dried to eliminate all moisture, so that they can be proportioned by weight without the necessity of considering the weight due to moisture. Finally, the bond is pulverized, very thoroughly mixed, and screened to remove the lumps. The vitrified bond is strong though brittle after the burning operation; and very little of it is necessary to hold the abrasive particles together, so that the wheels are porous and open-grained, allowing plenty of room for the chips and grinding solution. This latter quality obviously makes the wheel free cutting.

As the possible combinations of clays are almost endless, this is a branch of wheel manufacture which requires a great deal of experience. The specific composition of

the bond depends upon the hardness or "grade" of wheel desired and the character of the abrasive grains—whether they are of silicon carbide, aluminum oxide or emery. Variations in grade, however, are obtained only in a general way by varying the bond composition; the finer grade distinctions depend upon the quantity of bond.

Mixing

The abrasive of desired grain size is carefully weighed and placed with the bond in power mixing kettles having rotating paddles. Water is added, and the mixing proceeds until a smooth, uniform mixture is obtained.

It is very important that the correct amount of water be added, because too much water causes the abrasive grains and bond to separate, the former, being heavier, settling to the bottom. The time required for mixing depends upon the coarseness of the abrasive and the kind of wheel for which the mixture is intended.

Molding

Cylindrical sheet-steel bands or rings, somewhat larger than the wheel to be molded, are placed upon plaster slabs, thus forming molds. The mixture is drawn off from the mixing kettles into these molds, great care being taken to avoid entrapping bubbles of air in the mixture.

Drying

The slabs with the filled molds are removed to a dry room, where, under carefully controlled moisture and temperature conditions, the drying is accomplished. This process usually requires from 24 hours to a week, depending upon the kind and size of wheel. Some of the largest wheels must be given several weeks of drying.

Shaving

The wheel blank is next taken to the shaving department, usually located near the dry room, where it is removed from the

slab and placed upon a shaving machine. This is very similar to a potter's wheel, and consists of a revolving disc or table and a holder which carries the tools for performing the shaving operations. The shaving is done by both machine and hand-guided tools, the latter being used principally for wheels other than the so-called "straight wheels." The wheels are shaved over size to allow for the final truing after burning.

Burning

The kilns are commonly of the combination up and down draft type such as are used extensively for the firing of pottery. The wheels are "set" in the kiln in a manner very similar to that of pottery practice. Each is supported and protected from the fuel gases by a fire-clay container called a "sagger," which completely surrounds it. Great care is required in the setting to prevent warping or cracking of the wheels during the burning. When the kiln is full, the door is closed and luted with fire clay.

Coal is the fuel used, the fire boxes extending inward radially at the base of the kiln. The kilns are fired to a temperature sufficiently high to flow and vitrify the bonding materials. The time required for burning depends upon the size of the wheels and the size of the kiln; therefore, the wheels which will stand the quickest fire are placed in kilns which are fired satisfactorily in the shortest time. After burning, a kiln is sealed with fire clay and the contents allowed to cool or anneal.

In the burning operation two methods of determining temperatures are employed:

(1) Pyrometric cones—usually employed to show when the burning is completed.

(2) Recording pyrometers—to show the temperatures at all stages of the burning and the rate of increase at the beginning.

Pyrometric cones, commonly called Seger cones after their inventor Herman Seger, are small pyramids of clay so

compounded as to melt at definite temperatures. These are placed in the kiln so that they can be readily seen, and they indicate the progress of the burning. The appearance of the melted cones indicates when the burning is complete.

Recording pyrometers operate upon the principle that when the ends of two wires of different composition are joined and the junction heated a small electric current is set up in the wires. This current increases as the temperature of the junction increases, and is measured by means of a sensitive instrument known as a galvanometer. The two wires joined as described above constitute a thermo-couple. Readings on the galvanometer are readily translated into temperatures. For the higher temperatures, a platinum thermo-couple is used, one wire of which is composed of pure platinum, and the other of an alloy of platinum and rhodium. The recording pyrometers record the temperature of the kiln continuously, and afford a means of steady and absolute control of the firing, so essential to the proper burning of abrasive wheels.

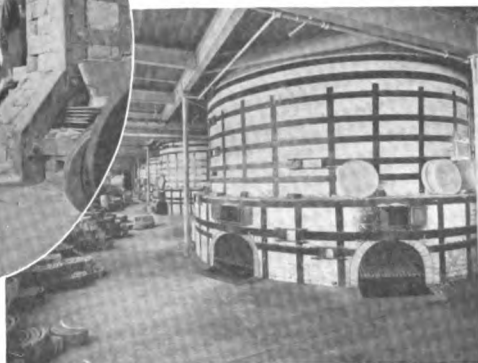
Truing

On leaving the kilns, the wheels are delivered to the truing room, where they are mounted in lathes or special truing machines and trued all over to dimensions. The tool used is a hardened-steel conical cutter. The grinding face of a small wheel is commonly trued with a dresser of the Huntington type.

Bushing

The arbor holes of most grinding wheels are bushed to size with lead, babbitt, or other soft material, the exceptions being very small wheels and very large wheels which are to be held in a chuck, or in some way other than by flanges on a spindle. A properly bushed wheel mounted on a spindle and running true may be removed, and when remounted will run true again within the limits required in any work except precision grinding.

The bushing must be true with the sides of the wheel, and its edges trimmed carefully; otherwise the wheel may break when placed upon the spindle and the flanges tightened. The diameter of the hole should not be much larger than the diameter of the spindle on which the wheel is to be mounted. If the hole is too large, it is difficult to mount the wheel so that it will run true and straight and not be out of balance.



Interior and Exterior Views of High-Temperature Kilns in Which Grinding Wheels Are Vitrified

Grading

The method of grading wheels commonly employed is not a mechanical test, although there are machines designed for grading. The most accurate grading is done by hand and requires considerable skill and experience. The tool used resembles a short screwdriver having a thin edge and a heavy handle. The operator presses the tool into the side of the wheel and turns or twists it slightly. The resistance offered to this twisting motion by the bonded abrasive indicates to the experienced man the grade of the wheel. He compares the resistance offered by the wheel under test with that offered by a test wheel of known grade.

Unfortunately different wheel-making firms express the same grade by different letters of the alphabet, in some cases opposed in sequence. Probably the Norton Company system of grading is most used. The first letters of the alphabet represent the softest wheels having vitrified and silicate bonds. For elastic wheels, numbers are used.

A grade is not an exact value. It is a range between limits, and all wheels which come within the range designated by any particular letter or number are of one grade and carry the same grade letter. As an example, grade L does not represent an exact value, but a range between two limits. It will thus be seen that a wheel marked L may be almost soft enough to be designated K, or it may be almost hard enough to be designated M, and still, if within the limits, it must be graded L.

The real purpose of the wheel-grade scale is to allow wheels to be identified and duplicated.

Balancing

All wheels over 12" in diameter are tested for balance. The wheel is centered on a mandrel, the ends of which rest on parallel horizontal ways, along which the wheel is rolled slowly and permitted to

Norton Wheel Grades.

<u>Elastic and Rubber</u>		<u>Vitrified and Silicate</u>	
<i>Softest Elastic Wheel</i>			<i>Softest Wheel</i>
<i>Elastic</i>	$\frac{1}{2}$	F	<i>Very soft</i>
		G	
	1	H	<i>Soft</i>
	$1\frac{1}{2}$	I	
	2	J	
	$2\frac{1}{2}$	K	
	3	L	<i>Medium</i>
	4	M	
	5	N	
		O	
<i>Rubber</i>	6	P	<i>Hard</i>
	7	Q	
		R	
		S	
		T	<i>Very hard</i>
		U	
		W	
		Z	
<i>Hardest Elastic Wheel</i>			<i>Hardest Wheel</i>
<i>Softest Rubber Wheel</i>			
<i>Hardest Rubber Wheel</i>			

come to rest. Naturally, the light side will be at the top. This point is marked and weights attached by means of a spring clip until, when the wheel is rotated 90° to either side, it remains in that position with no tendency to roll either way. The total weight of the clips and weights is marked on the wheel, and a sufficient amount of material is chipped out on the light side next to the hole, so that, after the opening is filled with lead, the wheel is restored to balance.

Speed Testing

As the last operation previous to packing, all wheels 6" in diameter and larger

are given a speed test by being mounted on a spindle enclosed in a steel protective shell, and operated at a speed about 50% above the speed at which the wheels are recommended to be run normally. Since the centrifugal force tending to break a grinding wheel is proportional to the square of the speed, a wheel which is tested at 50% above its normal operating speed sustains a stress about double that encountered in ordinary operation.

The workman who does the speed testing is required to go before a notary public and swear to the correctness of the test data which are recorded on the individual shipping check accompanying the wheel. A wheel that has survived this test and is properly mounted offers little chance of breakage in commercial service.

Inspection

All wheels are inspected carefully as a precaution against errors in shape, size, grain and grade, miscounts, and imperfections of any character, notably cracks, chipped places and blow-holes.

General Points in Connection with the Vitrified Process

The vitrified wheel has several qualities which make it applicable to over three fourths of the grinding done at the present time. On account of its porosity and the great strength of its bond, the amount of material removed per cubic inch of wheel wear is high. The wheel is not affected by water, acids, oils, climatic or ordinary temperature conditions. The structure of properly made wheels is uniform and free from hard or soft spots.

Long experience and great skill are necessary in the manufacture of vitrified wheels, in order that spoiled work may be reduced to a minimum. Under no circumstances can the drying or burning operations be hurried. Great care is required in the loading of the kilns, in order that wheels may not be warped or

cracked as a result of being improperly supported; and in the burning, that wheels may not be of some other grade than that intended.

2. Silicate Process

Bond, Mixing, Molding and Tamping

Silicate wheels derive their name from the fact that silicate of soda or water glass is the principal ingredient of the bond. Various filling materials are sometimes added. The accurately weighed batch of bond and abrasive is mixed very thoroughly and delivered to the molding floor, where the quantity required for a single wheel is weighed out, placed in a mold, and firmly tamped in place.

It is important that the bond and abrasive be so mixed as to secure the proper consistency, or "stickiness," and granular condition that are required for tamping the wheel to a uniform density, so that the wheel will not only be uniform throughout but will be uniform as compared with others of the same kind. The hardness of the wheel is determined by the quantity of bond and the amount of the tamping. Unlike the vitrified wheel, the molded type needs no shaving.

Baking

When the mold is removed, the wheel is dried for several hours, then placed in a specially built oven, from which all gases of combustion are excluded, and subjected to a temperature of 500° F. from 20 to 80 hours, depending upon its kind and size.

Finishing

As in the case of the vitrified type, the silicate wheels are trued to exact dimensions, graded, balanced, bushed and inspected.

Advantages of the Process

The advantages of the silicate process may be summarized as follows: It is rapid, and special wheels may be made in

a few days; it is dependable, as the baking process is easily controlled. Wheels of any size up to 60" in diameter or larger may be made. Wheels may be molded on iron centers or backs which would not stand the heat of the kiln.

3. Elastic Process

Bond, Mixing, Molding and Baking

The elastic bond consists essentially of shellac, which is mixed with the abrasive grain in a steam-heated mixing machine, thus producing a granular mixture of abrasive particles, each thoroughly coated with the bond. Wheels $\frac{1}{8}$ " thick and less are made by placing the material in heated steel molds of the exact size of the finished product, and consolidating it by means of a steel roller.



Presses for the Manufacture of Elastic Wheels

Thicker wheels are pressed hydraulically into steel molds. In either case, after the forming process, the wheels are placed in sand and baked for a few hours at a temperature of approximately 300° F. When finished they are nearly black in color. Elastic wheels thicker than $\frac{1}{8}$ " must be trued, but the work can only be done properly with a diamond.

Advantages of the Process

This process has the advantage that very thin wheels of sufficient strength to be used safely may be produced. The process

[8]

is rapid and easily controlled, and wheels may be molded on iron centers or backs. However, elastic wheels are less open and porous than vitrified wheels and will not withstand much heat.

4. Rubber Process

Bond, Mixing, Calendering and Vulcanizing

The rubber bond is pure rubber, to which is added sulphur as a vulcanizing agent. The abrasive grain is introduced by spreading it between the halves of a sheet of rubber folded upon itself. The whole is passed through a mixing roll, more abrasive is added, and this process continued until the proper content of abrasive is reached. The sheet is then passed through a calender roll which gives it the required thickness. The wheels are cut from the sheet in "dieing out" machines and are heated while under pressure to vulcanize the rubber. Rubber wheels more than $\frac{1}{8}$ " thick must also be trued with a diamond.

Advantages of the Rubber Process

Very hard, tough, thin wheels can be produced by this process.

Standard Shapes of Abrasive Wheels

When it is considered that under normal conditions from six to eight weeks are required to manufacture a standard grinding wheel, it is not difficult to realize why there are delays in making wheels of special shapes and sizes, or in cutting special shapes from plain wheels. With a view toward facilitating the supplying of wheels for the different makes of machines, lists of wheel sizes and shapes have been jointly prepared by wheel and machine manufacturers. Many machine designers and builders do not realize the difficulties of producing wheels for the varied types of machines.

Some of the more common wheel shapes are shown in the illustration on front cover.

[FEBRUARY, 1922]

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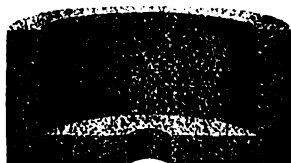
March  1922



Straight Wheel



Double Recess Wheel



Straight Cup Wheel



Flaring Cup Wheel



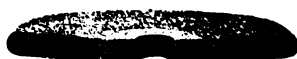
Cylinder Wheel



Offset Wheel



Dish Wheel



Saw Gumming Saucer Wheel

**Standard Shapes of Grinding Wheels as Recognized by
Grinding Wheel Manufacturers**



Grits and Grinds

Vol. XIII

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No. 7

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Selection of Grinding Wheels

[Third of the Series of Articles on
Theory and Practice of Grinding]

I. Importance of Selection

A proper selection of the grinding wheel is necessary for the most efficient results. In the selection of wheels for particular work, one wheel is not as good as another, although in precision grinding with skilled operators practically the same results may be obtained by the use of several different wheels. In this case the results are due primarily to the men who have acquired the art of grinding. They have, as a result of their experience, become artists in grinding; they know intuitively what to do, when and how to do it. Their personal experience accounts for the results.

There is, however, one wheel which is the best to use. Experience has established several principles which are of aid. To make the best selection, the work to be done must be studied and the selection of wheel determined by various factors.

II. Factors Governing Wheel Selection

Three general factors govern the selection:

- Characteristics of the wheel as determined by its manufacture.
- Nature of material to be ground.
- Factors having to do with methods and conditions of use.

1. Characteristics of Wheel as Determined by Its Manufacture

The Abrasive

The method of manufacture of grinding wheels, abrasive materials used and nature

of bond result in giving to the different types of wheels certain general characteristics as regards adaption to work.

In the first article of this series were given the characteristics aimed for in artificial abrasives. The silicon carbide abrasives differ materially from the aluminous abrasives. The grains of the former are intrinsically harder but are also more brittle due to the structure; the grains of the latter while not as hard are tougher and do not break apart as easily, and thus are able to withstand a greater stress. In addition the aluminous abrasives in their manufacture admit of a certain range of toughness due to variations in size of crystals and distribution of slag.

On account of the difference in physical characteristics of the two abrasives, a general rule has been established—namely, that aluminous abrasives are used for grinding materials of high tensile strength, and silicon carbide abrasives for those of lower tensile strength. While tensile strength alone is not the criterion, inasmuch as hardness and ductility influence the selection, experience has shown that in general the aluminous abrasives are particularly adapted for the grinding of materials of high tensile strength.

It is impossible to set a fixed tensile strength as representing the dividing line between the use of the two abrasives, but 50,000 pounds per square inch may be used. For metals of this strength or over, preferably an aluminous abrasive should be selected. For metals of lower tensile



strength, such as cast and chilled iron, non-ferrous metals such as copper, aluminum, zinc, tin and their alloys, and for most non-metallic substances such as wood, rubber, celluloid, pearl, marble and stone, silicon carbide abrasives are in general preferable.

Many experiments have been made to determine the cutting efficiency of different kinds of abrasives on various metals, and the results plotted in the form of curves. At approximately 40,000 pounds per square inch tensile strength, the curve of the silicon carbide abrasive (Crystolon) crosses that of the aluminous abrasive (Alundum). In this vicinity careful study should be made in the selection.

Reference has been made to variation in characteristics of aluminous abrasives (which are summed up and called temper) made possible in their manufacture. The Norton Company manufactures three principal abrasives known as:

Regular Alundum Abrasive

A dense, brown abrasive having a waxy appearance. It is a crystalline product, the crystals running as large as $\frac{1}{4}$ " in diameter. The impurities occur in very small percentages, and are in the form of opaque slag distributed in thin, irregular stringers through and between the crystals. Regular Alundum abrasive is tougher than either of the other two varieties described below, and therefore does not wear as rapidly.

Number 38 Alundum Abrasive

A very pure aluminous abrasive containing approximately 99% pure alumina. The crystals are large, but the abrasive is not as tough as either Regular or No. 66 abrasives, because it is very porous. There is practically no slag in this type of abrasive.

Number 66 Alundum Abrasive

An abrasive differing from Regular essentially in the fact that the crystals are of uniformly small size. It has a toughness between that of Regular and No. 38. The

slag in this abrasive is in the same form as in Regular Alundum abrasive.

The individual characteristics, above mentioned, enable an adaptation to be made. On certain metals and under certain conditions the grain particles of Regular Alundum abrasive may become dull, because they are too tough and do not break away properly. In this case instead of cutting, they heat the work, and if the material be finely heat-treated steel it may be spoiled. Hence No. 38 or No. 66 Alundum abrasives can be used to better advantage since they are less tough and therefore more friable, and break away more readily, exposing fresh cutting edges.

The proper cutting action should be sought for in all selections. The aluminous abrasives, being tougher and able to withstand a large amount of stress, require a sufficiently tough material to work against; otherwise the grain particles become dull and rub instead of cut. In the case of silicon carbide abrasives, if the material is too tough the grain particles break off too fast and the wheel becomes glazed and rubs instead of cutting. A wheel that rubs is not efficient since the output is lowered, and the wheel is wasted because of frequent dressings required to put it in cutting condition.

Characteristics Determined by the Bond

In addition to grain characteristics, the selection is affected by the nature of the bond, which is the material used to hold the abrasive particles together. The kind and amount of bond used impart distinctive characteristics to the wheel, as indicated in its grade.

Vitrified Bonded Wheels

The vitrified bonded wheels are standard for most grinding operations, the other types being used only when special conditions are involved. The vitrified process produces wheels of exceedingly strong bond and of a wide range of grades. These qualities, combined with their open, porous structure, adapt them for nearly all classes

Heat Treated Steels;	200,000	
Alloy Steels, Manganese Etc.	100,000	
100 to 125° or Higher	100,000	
Carbon Steel	100,000	
50° to 100° Carbon Steel	50,000	
Manganese Bronze;	75,000	
Low Carbon Cold Rolled Steel	60,000	
25° to 50° Carbon Steel	50,000	
Brass Rods	45,000	
10° to 25° Carbon Steel;	45,000	
Steel Casts; wrought iron	40,000	
Malleable iron;	35,000	
Aluminum Casts; Silver	30,000	
rolled copper	27,000	
Brass Castings	25,000	
Yellow Brass;	24,000	
White Metal	20,000	
Copper Castings;	20,000	
Large Gray Iron Castings	20,000	
Med and small Gray Iron Casts	20,000	
and Cast Iron; Gold	20,000	
Zinc	20,000	
Tin	4,000	

100,000 lb./sq. in.

200,000

100

0

0

100

LOW

MEDIUM LOW

MEDIUM

MEDIUM HIGH

HIGH

Steel

Cast Iron

Aluminum

Wrought Iron

Bronze

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used—Nos. 14 to 24—whether the wheel be a disc, cup or cylinder. Most wheels contain more than one size of grain, and on this account they are designated as “combination” wheels. For plane surface grinding, however, single grain or what are known as “straight grain” wheels are used, because such wheels are more open grained than combination wheels, and consequently there is more room between the grains for the removal of chips.

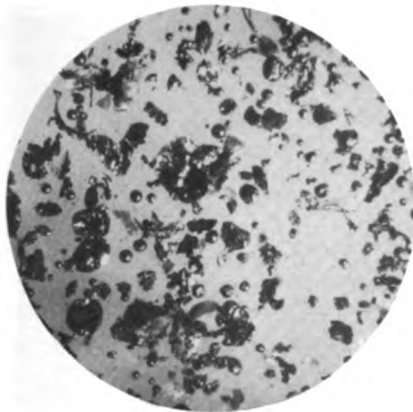
Grade Consideration

The grade of a wheel which represents the holding power between bond and grain has an influence in wheel selection. The proper selection is determined by the second and third general factors governing wheel selection—namely, “Nature of Material To Be Ground” and “Factors Due to Methods and Conditions.”



Chips from work ground with a wheel of the proper grade

retained a longer time. Exceptions to the foregoing are very ductile materials like babbitt, copper and soft brass, since ductile materials load a hard wheel.



Chips from work ground with a wheel too hard

In general the hard materials require the softer wheels and the less hard materials the harder wheels. The reason for this is that for proper wheel action on a hard material the bond should be soft enough to permit of wearing away at a rate sufficient to allow the grain to be broken off and torn out fast enough to keep fresh sharp grains cutting at all times. With a softer material which dulls the grain less, the bond may be harder and the grains

2. Nature of Material to be Ground

While the method of manufacture and the composition of wheels classify them in general for adaptation to work as previously noted, special consideration must be given to the material being ground.

Grinding may be divided into two general classes: offhand and precision. Offhand grinding includes all rough grinding on castings or other parts where the primary object is the quick removal of material, and also certain kinds of tool grinding.

In the rough grinding of castings, snagging, as it is called, finish and precision are not considered. The wheels selected, therefore, should be those of coarse grain for rapid cutting quality and removal of stock. Castings having smooth surfaces require coarser and softer wheels than those covered with sprues, sharp fins and irregularities. For castings having sharp fins, hard wheels must be used in order that there may not be excessive wheel wear. Grades R to U and grain Nos. 16 to 24 are usually used for this class of work, while grades M to P and grain Nos.

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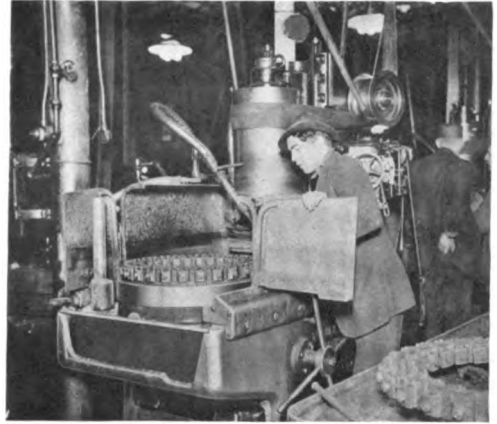
cup or cylinder wheel, require much softer wheels than those surface machines using a straight or disc wheel.

The machine should be kept in good condition, for good results from a grinding wheel cannot be expected unless the machine is in good repair and properly set up. If the wheel spindle is loose in its bearings, or the machine has a poor foundation, vibrations result and harder wheels are required than would be necessary if the machine were in proper condition. Vibrations from any cause necessitate the use of harder wheels than those normally required, since softer wheels wear away too fast.

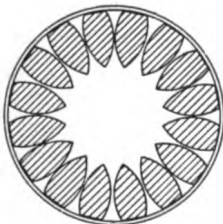
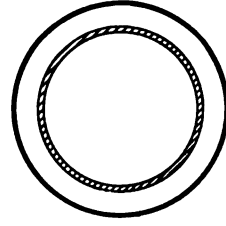
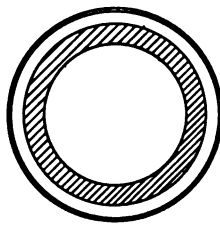
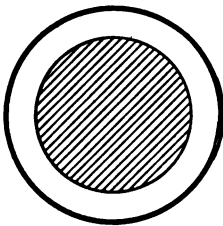
Contact

Contact has an important bearing on the grade (degree of hardness) of the grinding wheel in all classes of grinding, whether precision or offhand. In straight wheel grinding where the periphery of the wheel is used, the term "contact" means arc of contact, the width of the wheel being immaterial, assuming that the ma-

chine has ample power. With cup or cylindrical wheels, "contact" means the area of the wheel surface touching the work. In both cases narrow contacts (short lengths of arc or small amounts of area) require hard wheels, since the



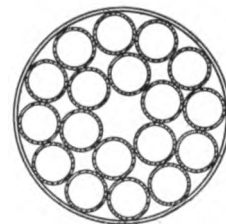
Blanchard Surface Grinding Machine Showing Automobile Push Rods Mounted on a Circular Chuck—Narrow Contact



Broad Contact



Medium Contact



Narrow Contact

SURFACE CONTACT

Examples of the Contact Offered to the Grinding Wheel by Different Classes of Work Ground on the Blanchard Machine



stress is brought upon a comparatively small number of grains. On the other hand, broad contact having a comparatively large number of grains cutting at the same time requires softer wheels.

Finish

In offhand grinding, finish is not usually considered, and in machine grinding a commercial finish is usually required. Where fine finish is desired and means are not available for proper truing of the wheel, a fine grain and a soft grade of wheel should be used. Whenever the wheel can be properly trued, however, wheels of coarser grain should be used. Under these conditions they will give any desired finish and much greater production. Silicate wheels give a better finish than the same grain and grade of vitrified wheels, and if an especially high degree of finish is desired the fine grain elastic and rubber wheels are used.

Speed of Work and Wheel

A proper wheel speed is necessary in order that the grain particles in the wheel may penetrate the surface to be ground and cut a chip. Within the proper surface speeds, it has been found by experiment that a change of 1,000 surface feet per minute represents approximately a difference of one grade in cutting action. An increase in speed makes the wheel act harder. Wheel makers have ascertained by experience the best speeds to use with wheels of different grades and processes of manufacture. These recommended speeds are given on the wheel shipping tags and should be followed by the users. The recommended wheel speeds for Norton wheels are:

	S. F. P. M.
Cylindrical grinding	5,500- 6,500
Internal grinding	5,000- 6,000
Snagging and general off-hand grinding on bench and floor stands	5,000- 6,000
Surface grinding	4,000- 5,000
Knife grinding	3,500- 4,000

Hemming cylinders	2,100- 2,400
Wet tool grinding	5,000- 6,000
Cutlery grinding	4,000- 5,000
Elastic and rubber cutting-off wheels	9,000-12,000

In precision grinding, the additional factor of work speed must also be considered, whether the work is revolving or reciprocating. With the same wheel an increase of work speed causes an increase in wheel wear; hence with high work speeds harder wheels should be used. Most grinding machines are arranged with variable work speeds for the purpose of adjusting the speed so as to produce the most efficient cutting action with the wheel used.

Personal Factor

The success with any wheel selected depends upon its proper use by the operator. He must know what wheel to select for a given piece of work and how to use it. Incorrect use results in waste and inefficiency.

In offhand grinding, it has been found that grinding costs may vary 100% on machines of the same kind and doing the same work in the same factory. The difference arises from the methods used. One man understands the proper use of the wheel, has greater skill and applies the wheel to the work properly.

In machine grinding, some manufacturers wonder why they cannot use the same kind of wheel for certain operations and obtain as good results as their neighbors obtain. Apparently there should be no difference. The work, wheels and speeds are the same, but the grinding cost is greater. The skill of the workman accounts for the difference in cost of one manufacturer's process over the other.

NOTE—The various factors affecting grinding wheel selection were given in tabular form in the July-August 1921 issue of "Grits and Grinds." The Norton Company table of grinding wheel recommendations for different classes of work was also given in that issue.

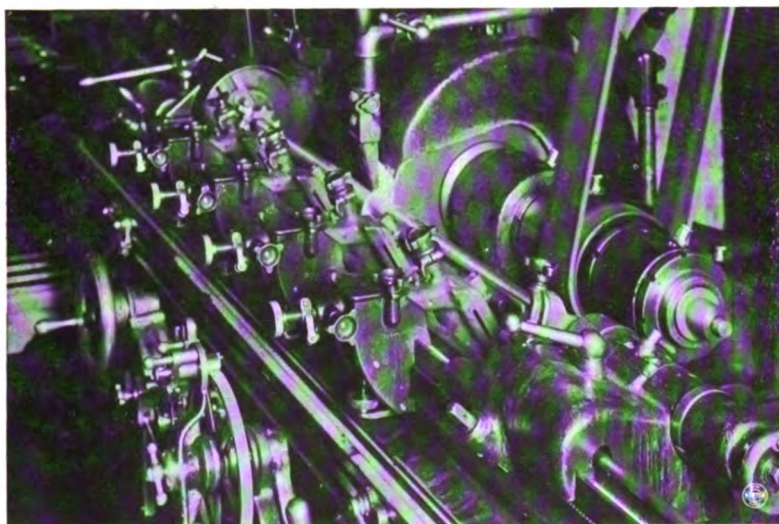
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GRITS and GRINDS

April 1922



Showing Work "Properly Steadyrested" in a Norton Machine for Cylindrical Grinding



Grits and Grinds

Vol. XIII

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No. 8

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Theory of Grinding

[Fourth of the Series of Articles on
Theory and Practice of Grinding]

The grinding wheel may be considered as a revolving cylinder covered with sharp tools, the abrasive grains. When revolving at a proper speed the grains act like cutters and cut chips like a milling cutter, although much smaller. It is the large number of cutting points and their frequent application which produce results.

As an illustration, it has been found that for a 45 grain wheel there are on the average eighteen grains per linear inch, or three hundred and twenty-four grains per square inch of surface. For an 18" diameter wheel with a 2" face, having a speed of 5,000 s. f. p. m., approximately 38,800,000 cutting points will act per minute. It is thus very evident that owing to the large number of them the results are definite and tangible, although the chips cut out are very small, almost infinitesimal.

The theory of the action of the cutting grains in cylindrical work has been discussed by Prof. G. I. Alden of the Norton Company in a paper presented at the annual meeting of the American Society of Mechanical Engineers held in December 1914.

The following has been taken with slight modifications from that paper. In figure 1,

Let C be the center of the wheel

c the center of the work

OP the radial depth of cut

OQ the arc of contact of wheel and work

The assumed directions of revolution of

wheel and work are indicated by the arrows. The term speed is used to represent the peripheral speed in feet per minute, whether referring to work or wheel. The radial depth of cut and the dimension of the chip are much exaggerated in figure 1, the real dimensions in actual work being exceedingly small.

Assume for a moment that there is but one abrasive grain or cutting point on the surface of the wheel and that this one grain is at O. On account of the revolution of the wheel the point O will move to Q in a certain time, and in the same time, due to the revolution of the work, the point Q will move up to the point W. As the speed of the work is usually very much less than the speed of the wheel, the distance QW will be much less than OQ. The cutting point will remove from the work a chip represented by OQW. From the outline or shape of the chip it appears at once that when the cutting point begins to act at O, its depth of cut is nothing, but that the depth of cut of the grain increases gradually to its maximum WS.

As the abrasive grain in a grinding wheel is set or fixed in the bond of the wheel, it is clear that the deeper the grain cuts into the work, the more the bond will be disturbed or worn away. This maximum grain depth of cut WS may for brevity be called simply GRAIN DEPTH OF CUT. There are actually a number of cutting particles along the arc of contact OQ, but each acts in the same manner as the

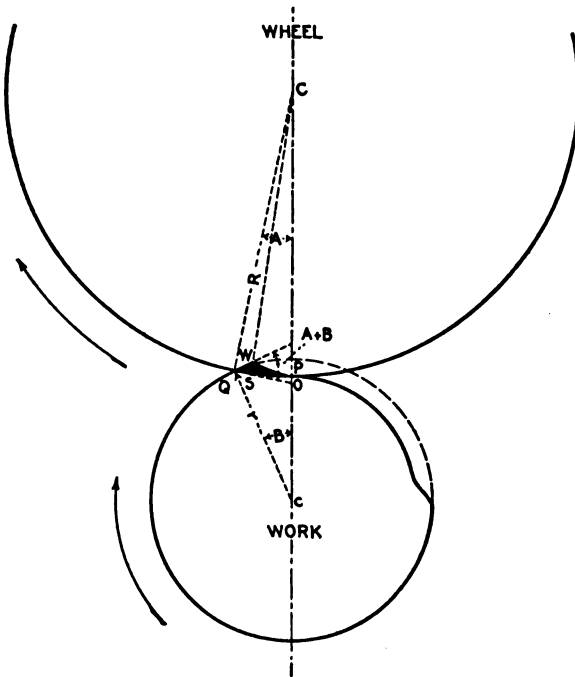


Fig. 1

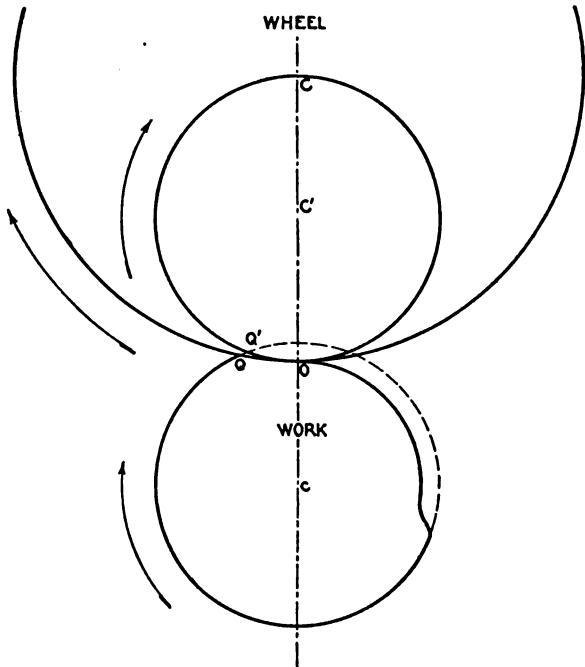


Fig. 2

single grain considered in the illustration. The actual grain depth of cut of each particle, however, will be the distance WS divided by the number of cutting grains or particles in action at once, or the number between O and Q .

When a grinding wheel is working properly, the abrasive grain in the wheel may be considered as cutting small chips from the work, and the surface of the work as cutting or wearing away the bond of the wheel. It is evident that the greater the grain depth of cut, the greater will be the wearing action of the work upon the bond of the wheel. As long as the bond is being worn away just as fast as the abrasive grains of the wheel are being worn down, the wheel will continue to work well. If the bond is worn away too rapidly, the wheel will appear too soft, and will wear away too rapidly.

If the cutting grains wear down faster than the bond is cut or worn away, the face of the wheel will become glazed and the wheel will not cut freely. These considerations lead directly to the conclusion that the action of a given wheel on a given kind of work is almost entirely dependent upon the grain depth of cut. If the grain depth of cut is too great, the wheel wears away too rapidly. If the grain depth of cut is too small, the wheel may glaze. It is, therefore, important to know how the grain depth of cut may be regulated.

From figure 1 it is evident that WS will increase if QW increases and vice versa; but QW depends upon the speed of the work. Therefore, if the speed of the wheel remains constant and the speed of the work increases, WS will increase. The correct working of the wheel therefore depends upon the relation of QW to OQ , or upon the relation of work speed to wheel speed.

If the wheel speed and all other conditions except work speed remain constant, the grain depth of cut will increase as the work speed increases, and diminish as the work speed diminishes. Also the work speed and all other conditions except wheel

speed remaining constant, the grain depth of cut will increase as the wheel speed diminishes and vice versa.

Effect of Change in Diameter of Wheel or Work

In figure 2, let

C be the center of a grinding wheel
 C' be the center of a smaller grinding wheel

c be the center of the work

Suppose the wheel whose center is at C to have worn down until its center is at C' , the work diameter remaining the same. Let the radial depth of cut and work speed also remain constant. This insures the same rate of production in each case. Let the wheel speed also be the same in each case.

It will be seen from figure 2 that the smaller wheel will have a shorter arc of contact with the work than the larger wheel, or that OQ' is less than OQ . Since the wheel speed in both cases is assumed to be the same, the number of chips cut from the work each minute will be the same; but as the chips cut by the smaller wheel are shorter, and as the volume of all the chips cut each minute is the same, it follows that the thickness of the chips cut by the smaller wheel is greater than the thickness of the chips cut by the larger wheel. In other words, the grain depth of cut increases as the wheel diameter diminishes. Therefore the bond should wear away faster as the wheel becomes smaller, and the smaller wheel should appear softer.

In many cases, as the wheel wears down the speed of the wheel is allowed to diminish, and when this is the case the grain depth of cut will be increased on account of the diminished wheel speed, as well as because of the smaller wheel. Following the same line of reasoning, it is easily shown that if the work diameter is increased (all other factors remaining the same), a longer chip will be cut from the work; and as the number and volume of chips remain constant for each unit



of time, the thickness of the chips must diminish, or the grain depth of cut must be less. Therefore a wheel, other conditions being the same, should appear harder as the diameter of the work increases. A proper increase of work speed on the larger work will bring up the grain depth of cut to what it was on smaller work.

From purely theoretical considerations the conclusions may be summarized as follows:

(a) Other factors remaining constant, increase of work speed increases grain depth of cut and makes a wheel appear softer.

(b) Similarly, a decrease of wheel speed increases the grain depth of cut and makes a wheel appear softer.

(c) Similarly, diminishing the diameter of the grinding wheel increases the grain depth of cut, and increasing the diameter of the wheel decreases the grain depth of cut.

(d) Similarly, making the diameter of the work smaller increases the grain depth of cut. Conversely, making the diameter of the work larger makes the grain depth of cut smaller.

These conclusions are based upon the assumption that the wheel is free cutting and that the chips are thrown off or escape and do not load the wheel.

In applying the principle that grain depth of cut is the main factor in the operation of a good grinding wheel, it must be remembered that the correct relative speeds of work and of wheel must be found by trial for each wheel and each kind of work. When this has been done, the principle of grain depth of cut will enable one to know the direction in which to make the changes of work speed or wheel speed, to adapt the wheel to changes in its own diameter or to other sizes of the same kind of work.

In the preceding it has been assumed that the object of grinding is to remove stock rapidly or, in other words, to obtain a high rate of production. Often, however, the character of finish of a ground

surface is of primary importance. From the point of view of grain depth of cut, it results that in order to obtain a very smooth surface by grinding, the grain depth of cut should be very small, and therefore that the work speed should be relatively slower for finishing than for roughing.

That the bond may be worn away by a very small grain depth of cut, it would be expected that generally a softer wheel would be used for fine finishing than for roughing. A very hard glazed wheel may sometimes produce a mirror-like surface on the work, the action in this case being a sort of burnishing process.

Mathematical Equation of Grain Depth of Cut

In figure 1,

Let $OQ = l$ = arc of contact of wheel and work

n = number of cutting particles per unit length of circumference of wheel

V = surface velocity of the wheel

v = surface velocity of the work

T = time it takes a point on wheel to go from O to Q , and also time it takes point on work to go from Q to W

d = grain depth of cut

$$\text{Then, } l = VT \text{ or } T = \frac{l}{V}$$

For all practical purposes, the figure QWS may be considered a right triangle with the angle at Q equal to $(A + B)$.

Then $QW = vT$

and $WS = vT \sin (A + B)$

$$d = \frac{WS}{nl} = \frac{vT}{nl} \sin (A + B)$$

$$\text{or since } T = \frac{l}{V}$$

$$d = \frac{v}{Vn} \sin (A + B)$$

which shows that the radial depth of cut varies directly as the work speed and as $\sin (A + B)$ and inversely as the wheel speed.



TABLE 1—ARCS OF CONTACT

Radial Depth of Cut in Inches		0.0005	0.001	0.0015	0.002	0.0025	0.003
	Work Diameter Inches	Arcs of Contact					
12" Wheel	$\frac{1}{2}$	0.0158	0.0210	0.0270	0.0307	0.0346	0.0378
	1	0.0212	0.0318	0.0373	0.0429	0.0482	0.0526
	2	0.0291	0.0413	0.0507	0.0584	0.0654	0.0711
	3	0.0346	0.0490	0.0600	0.0692	0.0775	0.0848
	4	0.0396	0.0547	0.0689	0.0775	0.0866	0.0949
	6	0.0448	0.0634	0.0774	0.0894	0.1001	0.1095
	8						
	12						
	24 Inf.	0.0775	0.1095	0.1342	0.1549	0.1732	0.1898
18" Wheel	$\frac{1}{2}$	0.0220	0.0311	0.0377	0.0436	0.0485	0.0533
	1	0.0299	0.0428	0.0521	0.0598	0.0669	0.0735
	2	0.0362	0.0504	0.0620	0.0717	0.0801	0.0878
	3	0.0401	0.0574	0.0699	0.0810	0.0900	0.0990
	4	0.0477	0.0672	0.0824	0.0950	0.1061	0.1162
	6						
	8						
	12						
	24 Inf.	0.0948	0.1341	0.1638	0.1897	0.2121	0.2324
24" Wheel	$\frac{1}{2}$						
	1	0.0294	0.0423	0.0521	0.0604	0.0676	0.0742
	2	0.0364	0.0515	0.0631	0.0728	0.0814	0.0892
	3	0.0407	0.0582	0.0714	0.0827	0.0925	0.1013
	4	0.0489	0.0691	0.0846	0.0977	0.1095	0.1189
	6	0.0546	0.0773	0.0947	0.1095	0.1224	0.1340
	8	0.0631	0.0895	0.1093	0.1264	0.1413	0.1549
	12	0.0777	0.1095	0.1342	0.1549	0.1731	0.1896
	24 Inf.	0.1097	0.1548	0.1896	0.2189	0.2448	0.2682

TABLE 2—SIN (A + B)

Radial Depth of Cut in Inches		0.0005	0.001	0.0015	0.002	0.0025	0.003
	Work Diameter Inches	Sin (A + B)					
12" Wheel	$\frac{1}{2}$	0.06581	0.09678	0.10999	0.12807	0.14379	0.15724
	1	0.04686	0.06888	0.08084	0.09287	0.10439	0.11396
	2	0.03394	0.04822	0.05914	0.06816	0.07626	0.08294
	3	0.02879	0.04075	0.04997	0.05768	0.06453	0.07066
	4	0.02573	0.03649	0.04589	0.05163	0.05769	0.06323
	6	0.02238	0.03167	0.03868	0.04469	0.05002	0.05475
	8						
	12						
	24 Inf.	0.01291	0.01826	0.02236	0.02582	0.02886	0.03162
18" Wheel	$\frac{1}{2}$	0.06394	0.06596	0.07948	0.09210	0.10231	0.11224
	1	0.03321	0.04751	0.05793	0.06645	0.07430	0.08167
	2	0.02813	0.03916	0.04842	0.05578	0.06229	0.06830
	3	0.02448	0.03501	0.04271	0.04951	0.05497	0.06051
	4	0.02119	0.02981	0.03661	0.04221	0.04715	0.05163
	6						
	8						
	12						
	24 Inf.	0.01053	0.01490	0.01826	0.02108	0.02356	0.02582
24" Wheel	$\frac{1}{2}$						
	1	0.03246	0.04582	0.05647	0.06541	0.07322	0.08903
	2	0.02731	0.03861	0.04730	0.05462	0.05817	0.06687
	3	0.02375	0.03394	0.04167	0.04822	0.05395	0.05910
	4	0.02036	0.02877	0.03535	0.04069	0.04564	0.04997
	6	0.01821	0.02575	0.03155	0.03651	0.04080	0.04467
	8	0.01576	0.02238	0.02731	0.03160	0.03531	0.03872
	12	0.01294	0.01826	0.02238	0.02582	0.02885	0.03160
	24 Inf.	0.00914	0.01290	0.01580	0.01824	0.02045	0.02235



The TABLES opposite enable an application of the formula to be easily made.

Table 1 gives lengths of arcs of contact between wheel and work for three different diameters of wheels. Table 2 gives the value of $\sin(A + B)$ for the dimensions of wheel and arcs of contact as given in table 1.

An application of the tables will show

how the grain depth of cut varies owing to changes in the radial depth of cut.

For further details the reader is referred to the original paper, "Operation of Grinding Wheels in Machine Grinding"; Transactions, American Society of Mechanical Engineers, volume 36, 1914, paper No. 1446.

Swing Frame Machines and Their Application

The swing frame grinding machine, as its name implies, is so constructed that the grinding wheel can be applied over a large area. The wheel is mounted on the end of one or more links, which permits the operator to move it in any desired direction. Castings that are too large to lift by hand and those easily

a belt from the motor or countershaft. This type may be suspended from overhead by means of hangers. It can also be mounted on a pedestal.

With the direct driven machine, the wheel may be perpendicular to the shaft (figure 1) or parallel, as shown in figure 2. A type of machine having the wheel

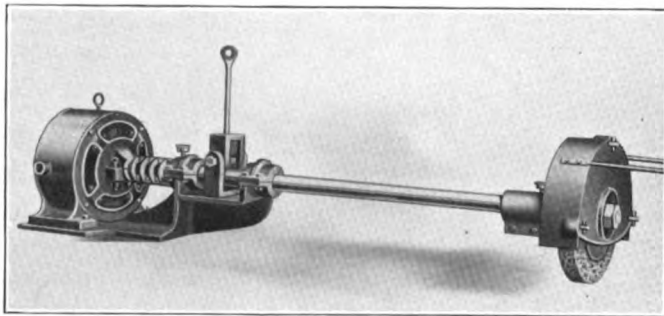


Fig. 1. Hassel Grinder. Pittsburgh Steel Foundry Co., Pittsburgh, Pa.

handled by a crane are ground with swing frame machines.

There are two types: motor driven and belt driven. Each one has its distinctive design.

Motor driven machines are of two kinds: direct and indirect drive. The grinding wheel in the latter machine is driven by

parallel to the shaft, mounted on pedestal, is illustrated in figure 5.

Inasmuch as the wheel is mounted on one end of a long arm, its weight must be counterbalanced. In one method counterweights are attached to the end of a rope which passes through pulleys on the ceiling and fastens to the wheel

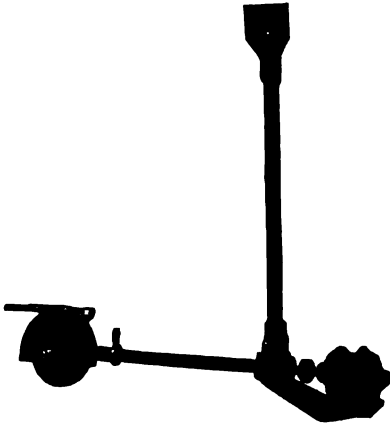


Fig. 2. Builders Iron Foundry, Providence, R.I.

head (figure 4). In the other method the lever takes the place of the rope and pulleys and, in addition to balancing the weight of wheel, the vertical link can be balanced by a weight as shown in figure 3.

In other widely known and commonly used types of direct motor driven ma-

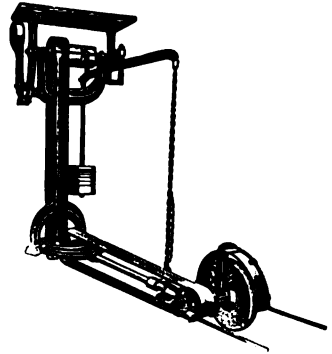


Fig. 3. Excelsior Tool and Machine Co. East St. Louis, Ill.

chines, the motor itself acts as a balancing weight.

Machines which mount wheels 18" or larger are ordinarily equipped with $7\frac{1}{2}$ -hp. motors.

Practically all belt driven machines are suspended from overhead hangers. The wheel is balanced by the overhead rope and pulley method (figure 6). In some machines the wheel is mounted

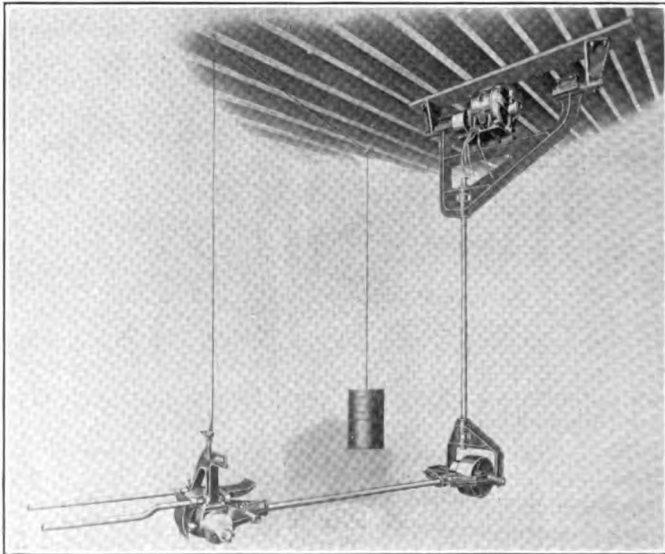


Fig. 4. Safety Emery Wheel Co., Springfield, Ohio

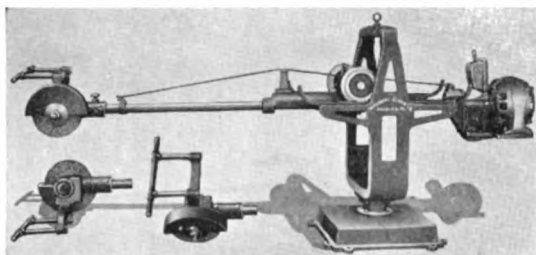


Fig. 5. Mummert-Dixon Co., Hanover, Pa.

between bearings (figure 7), while in others it is mounted outside of the two bearings (figures 3 and 4).

Modern swing frame grinding machines are equipped with adequate wheel guards or safety flanges for the protection of the operator, as illustrated in figure 1.

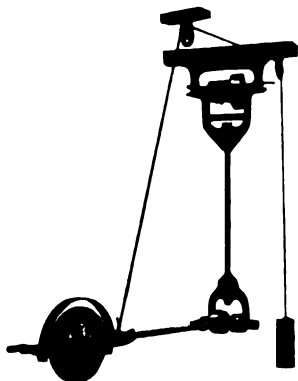


Fig. 6. The Sterling Grinding Wheel Co. Tiffin, Ohio

Application of Machines

For the grinding of billets in steel mills the swing frame machine is indispensable. In order to grind out the seams and checks, from 1 to 20 pounds of steel are removed from each billet. In the manufacture of manganese-steel railroad equipment such as frogs, switches, and crossovers, grinding wheels must be used because the metal cannot be machined with steel tools. Swing frame machines are used to rough grind these parts as well as for safe and vault castings, dredge buckets, and work

of similar character. Steel foundries usually have a battery of these machines to snag the larger castings. They are also employed in gray-iron foundries. Large motor castings are economically ground with these machines.

Snagging wheels on swing frame machines should be operated at 5,000 to 6,000 s.f.p.m. This range of speeds has been found by experience to give most satisfactory results. In order to obtain uniform results throughout the life of a wheel, the surface speed should be maintained as nearly constant as possible. To do this, it is a good plan to arrange a battery of swing frame machines some of which are operated at higher speeds than others. In this way wheels can be transferred from one machine to another as the diameter is reduced.

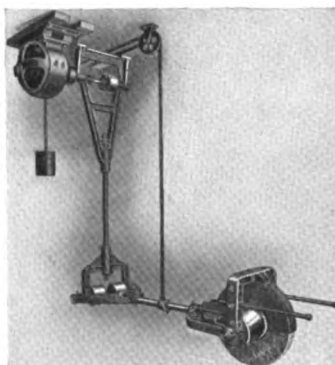


Fig. 7. Bridgeport Safety Emery Wheel Co. Bridgeport, Conn.



The following wheels are recommended for use on swing frame machines:

	First Selection Grain and Grade	Usual Range of Grain and Grade
High carbon steel billets	14-R Alun. vit.	16-Q to 12-S
Alloy-steel billets	20-R " "	20-P " 12-R
Manganese-steel castings	16-R " "	16-Q " 14-U
Steel castings	12-S " "	12-R " 10-W
Gray-iron castings	16-U Cry. " "	16-S " 16-U

Vibration in swing frame machines results in abnormally high wheel wear, rapid machine depreciation, and fatigue of the operator. Well-adjusted bearings

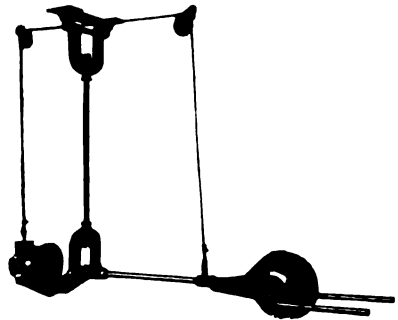


Fig. 8. The Springfield Manufacturing Co. Bridgeport, Conn.

If the wheel does become badly out of round, it should be carefully trued.

Other interesting points in connection with the use of wheels are discussed in a booklet, "Snagging," which will be sent on request.

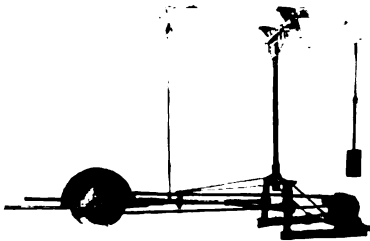


Fig. 9. Pittsburgh Grinding Wheel Co. Rochester, Pa.

are necessary if wheels are to run smoothly and remain true. The operator should use his best judgment in applying the wheel to the work. Carelessness will soon cause the wheel to be worn out of round, and this condition results in pounding it to pieces.

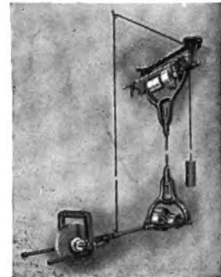


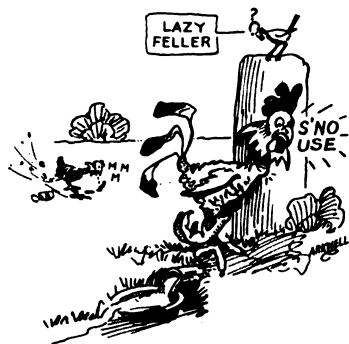
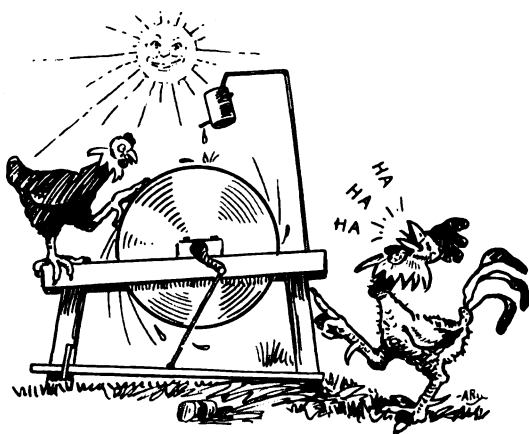
Fig. 10. The Ford-Smith Machine Co., Ltd. Hamilton, Ont.



THE STORY OF THE LITTLE BLACK HEN

Said the little red rooster, "Gosh all hemlock! Things are tough,
Seems that worms are getting scarcer, and I cannot find enough,
What's become of all those fat ones is a mystery to me;
There were thousands through that rainy spell—but now where can they be?"

The old black hen who heard him
didn't grumble or complain,
She had gone through lots of dry
spells, she had lived through
floods of rain,
So she flew up on the grindstone,
and she gave her claws a whet,
As she said, "I've never seen the
time there weren't worms to
get."



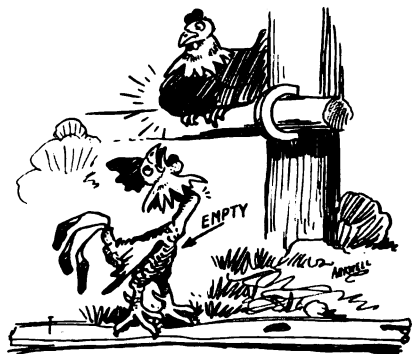
She picked a new and undug spot, the
earth was hard and firm,
The little rooster jeered, "New ground!
That's no place for a worm.
The old black hen just spread her feet, she
dug both fast and free,
"I must go to the worms," she said, "the
worms won't come to me."



The rooster vainly spent his day, through habit, by the ways
Where fat, round worms had passed in squads back in the rainy days.
When nightfall found him supperless, he growled in accents rough,
"I'm hungry as a fowl can be. Conditions sure are tough."

He turned then to the old black hen and said, "It's worse with you,
For you're not only hungry but you must be tired too.
I rested while I watched for worms, so I feel fairly perk;
But how are you? Without worms too? And after all that work?"

The old black hen hopped to her perch
and drooped her eyes to sleep,
And murmured in a drowsy tone, "Young
man, hear this and weep.
I'm full of worms and happy, for I've dined
both long and well.
The worms are there as always—but I
had to dig like hell!"



Oh, here and there red roosters still are holding sales positions.
They cannot do much business now because of poor conditions.
But soon as things get right again they'll sell a hundred firms—
Meanwhile the old black hens are out and gobbling up the worms.

(By E. D. Wolf of David Adler & Sons, Milwaukee)

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